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COMPARATIVE TESTS OF FRICTION LOSSES IN CEMENT LINED AND TAR COATED CAST IRON PIPE[1]

By MELVIN L. ENGER[2]

The tests were made at the Hydraulic Laboratory of the University of Illinois for the American Cast Iron Pipe Company of Birmingham, Alabama, on 4-inch, 6-inch, and 8-inch pipe furnished by the Company. The purpose of the tests was to determine the loss of head in cement lined and tar coated pipe for various rates of flow.

The pipe lines were laid outward from the Hydraulics Laboratory as shown in figure 1, along a concrete sidewalk and returned to the laboratory with the return pipe vertically above the outgoing line and resting on wooden supports, as shown in figure 2. Twenty lengths of cement lined pipe were laid in the outgoing line and eighteen lengths of tar coated pipe in the return line. The return bend consisted of two 8-inch standard cast-iron quarter bends with suitable reducers in the case of the 4-inch and 6-inch pipe tests. This arrangement is shown in figure 3.

The pipe lines were set up by experienced workmen. The joints were made with lead and jute and there was no leakage from the lines during the tests. The alignment of the different pipe lines was very good.

The average internal diameters of the pipes were determined by

[1] Presented before the Chicago Convention, June 9, 1927.

[2] Professor of Mechanics and Hydraulics, University of Illinois, Urbana, Ill.

averaging the vertical and horizontal inside diameters of each length of pipe about 8 inches from the ends. The average diameters were found to be as follows:

NOMINAL DIAMETER OF PIPE	INTERNAL DIAMETER OF PIPE	
	Cement lined	Tar coated
inches	*inches*	*inches*
4	3.61	3.96
6	5.84	5.88
8	7.86	7.97

Measurement of rate of flow. The flow was measured by an 88- by 3.5-inch Venturi meter shown in figure 4. The meter was cali-

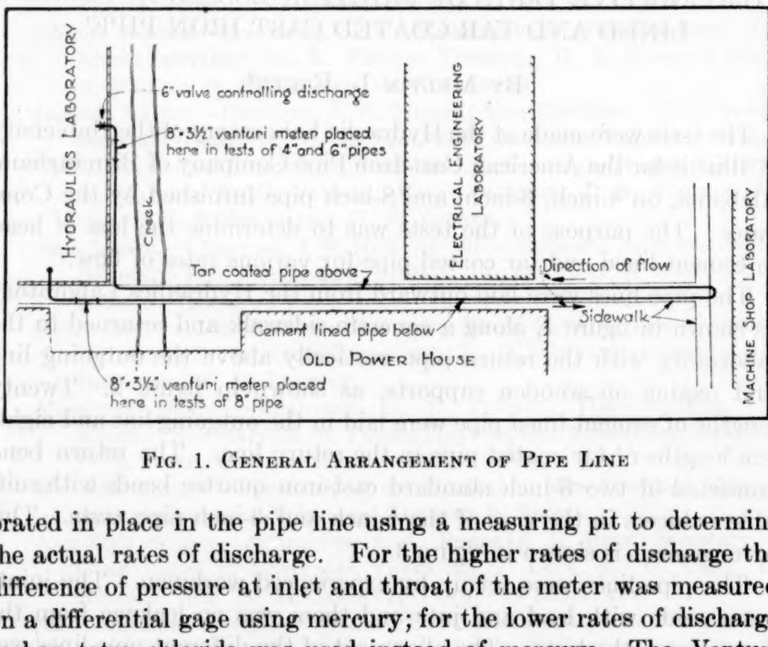

FIG. 1. GENERAL ARRANGEMENT OF PIPE LINE

brated in place in the pipe line using a measuring pit to determine the actual rates of discharge. For the higher rates of discharge the difference of pressure at inlet and throat of the meter was measured on a differential gage using mercury; for the lower rates of discharge carbon tetra chloride was used instead of mercury. The Venturi meter was calibrated using each kind of differential gage.

Piezometers. At the beginning and end of the portion of the pipe in which the loss of head was to be measured, four openings, each $\frac{3}{16}$-inch in diameter, were drilled at opposite ends of vertical and

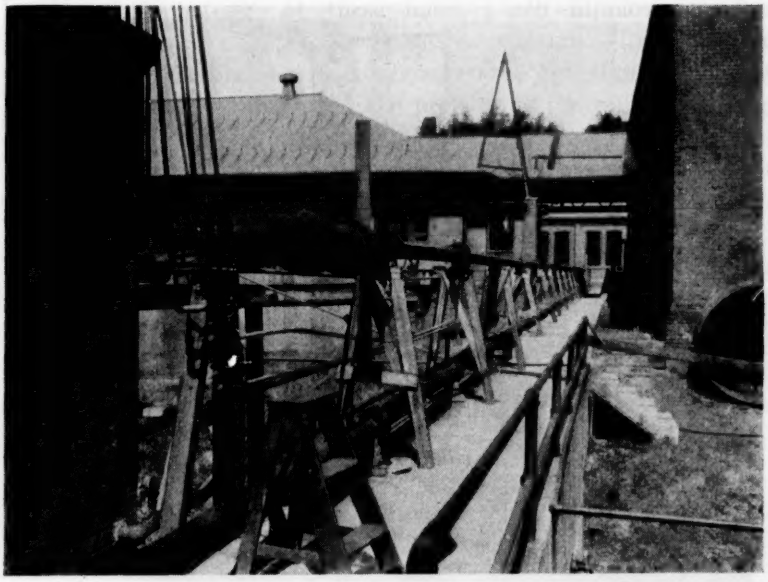

FIG. 2. RELATIVE POSITIONS OF OUTGOING AND RETURN PIPES

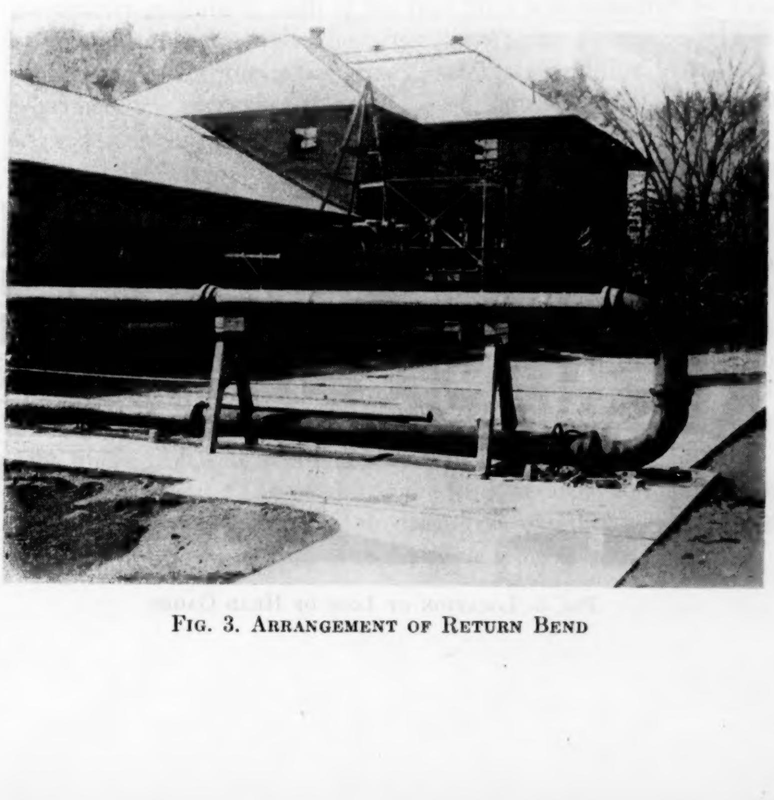

FIG. 3. ARRANGEMENT OF RETURN BEND

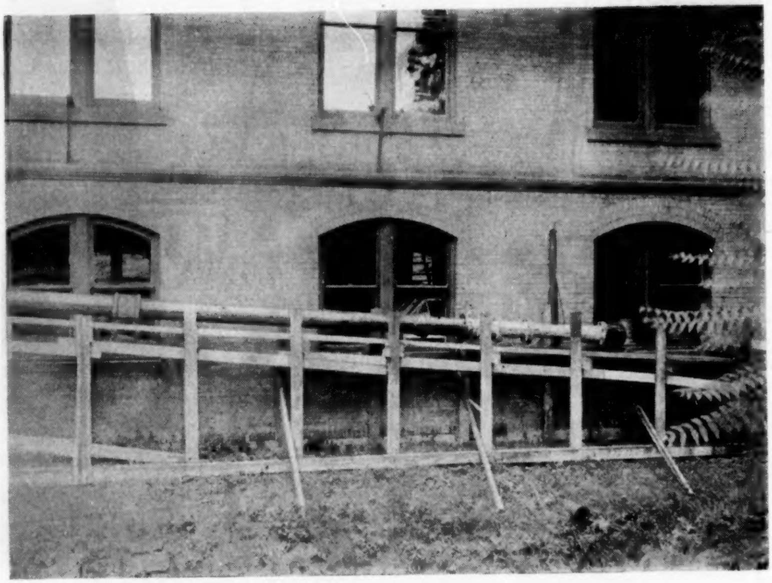

FIG. 4. LOCATION OF VENTURI METER

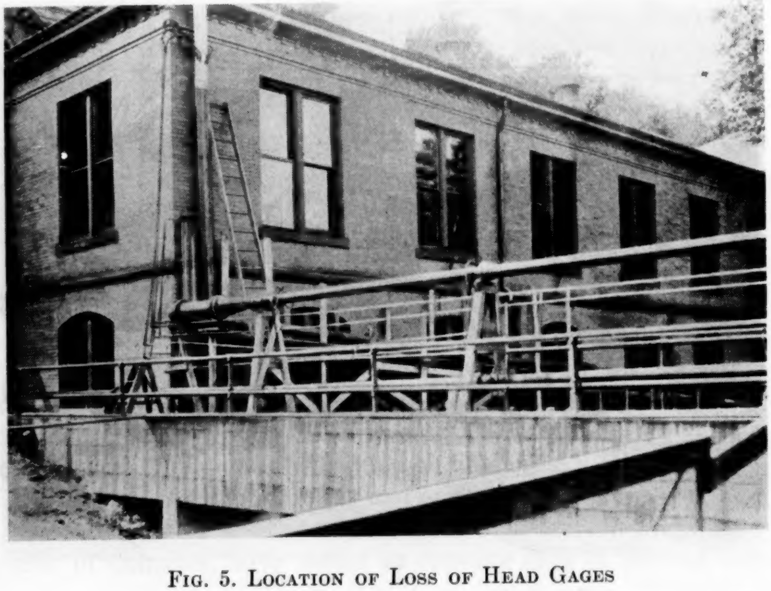

FIG. 5. LOCATION OF LOSS OF HEAD GAGES

horizontal diameters. At these holes $\frac{1}{4}$-inch nipples were held against soft rubber gaskets by means of a clamp. Rubber tubing was used to make the connection between the $\frac{1}{4}$-inch nipples and the $\frac{1}{2}$-inch pipe which transmitted the pressure to the differential gages used in measuring the loss of head. By this arrangement the pressure at the piezometer was the average of the pressure at the four openings, tending to eliminate the effect of local disturbances of flow on the pressure.

The distances over which loss of head was measured were as follows:

SIZE OF PIPE	DISTANCE OVER WHICH LOSS OF LEAD WAS MEASURED	
	Cement lined	Tar coated
inches	*feet*	*feet*
4	193.15	181.04
6	218.50	182.80
8	192.50	193.17

Measurement of loss of head. The loss of head between two piezometer sections in each of the pipe lines was measured by means of differential gages. For the larger losses of head mercury was used in the gages, for the lower losses carbon tetra chloride was used. The mercury gages were about 5 feet high and the carbon tetra chloride gages about 15 feet high. The gages are shown in figure 5.

Water supply. The water was pumped from a pump to a standpipe 4 feet in diameter and 60 feet high. The water was delivered from the standpipe into the experimental pipe line by an independent 12-inch pipe line. The standpipe absorbed pump pulsations which otherwise would have been troublesome in the differential gages.

Method of conducting tests. The rate of discharge through the pipe line was controlled by means of a gate valve at the end. When the flow had become steady after a change of the valve opening the differential gages on the Venturi meter and on the two sections of pipe under test were read simultaneously.

Results of tests. The results of the tests, reduced to losses of head per thousand feet of pipe, with discharges expressed in gallons per minute, are shown plotted to logarithmic scale in figure 6.

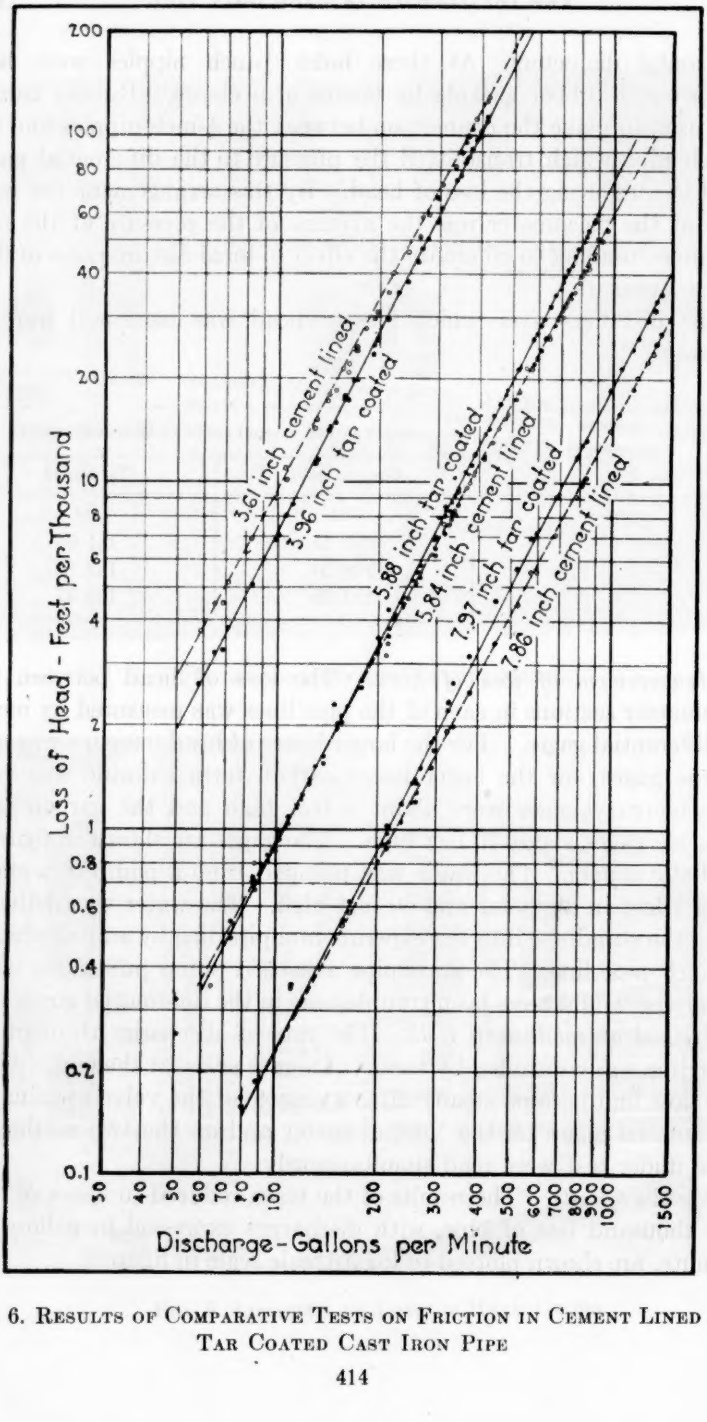

FIG. 6. RESULTS OF COMPARATIVE TESTS ON FRICTION IN CEMENT LINED AND TAR COATED CAST IRON PIPE

The following equations, in which h is the loss of head per thousand feet, Q is the rate of discharge in gallons per minute and d is the diameter in inches, were determined from the experiments.

For cement lined pipe

$$h = 1.10 \frac{Q^{1.83}}{d^{4.89}}$$

For tar coated pipe

$$h = 0.94 \frac{Q^{1.94}}{d^{5.00}}$$

The equations should apply quite well to pipe lines as large as 12 inches in diameter and be useful in estimating the friction loss in larger pipes. It should be emphasized that d is the *actual* internal diameter.

Cement lined pipe has a much smoother interior surface than new tar coated cast iron pipe. An uncoated cast iron pipe has a relatively rough interior surface. The tar coating makes the surface smoother, but there are many pinnacles which project above the general surface and cause a decided disturbance in the flow of the water. The cement lining is, or should be, thick enough to cover the pinnacles. The wetted surface can be made very smooth by means of the cement lining. The bond between the pinnacles and the cement no doubt explains the adhesion which permits cutting and calking without serious injury to the cement lining.

The effect of the increased smoothness of the cement lined pipe is to give it a greater carrying capacity for a given loss of head than new tar coated pipe of the *same* diameter, compensating for the reduction in internal diameter due to the cement lining. The tests indicate that, for velocities of flow between 1 and 2 feet per second, a cement lined pipe having an internal diameter 3 per cent less than new tar coated pipe has about the same carrying capacity. At velocities between 9 and 10 feet per second a cement lined pipe having an internal diameter 7 per cent less than new tar coated pipe has about the same carrying capacity.

The relative smoothness of the two linings is shown by the values of "C" in the Hazen and Williams formula from the tests calculated

for a velocity of about 3.14 feet per second. These values are shown below.

KIND OF LINING	INTERNAL DIAMETER	COEFFICIENT C IN HAZEN AND WILLIAMS FORMULA
	inches	
Cement lined pipe	3.61	149
	5.84	151
	7.86	150
Tar coated pipe	3.96	134
	5.88	140
	7.97	132

THE ONE TON LIQUEFIED CHLORINE GAS CONTAINER[1]

By Robert T. Baldwin[2]

Commercially, liquefied chlorine gas became available in 1888 in Germany. Shortly thereafter the Badische Anilin-und Soda Fabrik introduced it into the United States. It was shipped in seamless steel cylinders containing about 100 pounds each. These cylinders were fitted with special valves, but were without safety devices. Such packages obviously carried on the tradition of shipping compressed gases in steel cylinders of small capacity, and, moreover, dry liquid chlorine is an inert substance with no appreciable action on iron or steel. However, the imports of German liquid chlorine did not grow for several reasons, viz.: (1) the loaded cylinders were carried as deck loads and were subject to instant jettison in the event of cylinder leaks; (2) there was a heavy American tariff on the steel cylinders, and endless customs red tape in securing drawback of the duty or earmarking of the cylinders; (3) industries requiring chlorine were using bleaching powder and were loath to try a new substance which might not arrive in time for their needs. In 1909 the American liquid chlorine industry started, and the first shipments were made in hundred pound seamless steel cylinders imported from Germany. In the same year the first American Class V tank car holding 30,000 pounds made its appearance. Later seamless steel cylinders of American make holding 150 pounds came into common use.

In 1910 a few steel containers, approximately 30 inches in diameter and 6 feet in length, were devised to hold 2000 pounds of liquid chlorine. This container was a longitudinally welded steel cylinder with welded convex heads and was tested at 500 pounds hydrostatic pressure per square inch. One head had a manhole making internal inspections very easy; and the manhole cover was equipped with two valves, and internal piping of suitable lengths for the eduction of either liquid or gaseous chlorine. These containers had no safety devices and were accepted by the common carriers as box car freight. They were satisfactory both from a safety and technical standpoint.

[1] Presented before the Chicago Convention, June 10, 1927.

[2] Secretary, The Chlorine Institute, Inc., 30 East 42 Street, New York, N. Y.

In 1917 an improved container, substantially the one now in use, was devised for the export shipment of liquid chlorine for chemical warfare gases. This container, like the few of the earlier design, was accepted during the war emergency for transportation by the common carriers in carload and less than carload lots and was satisfactory from a safety and technical standpoint, although not formally approved by either the Bureau of Explosives or the Interstate Commerce Commission, both of which bodies regulate the shipment of compressed gases as well as explosives. In 1920, however, application was made to the Interstate Commerce Commission for regulations permitting the use of this ton chlorine container in carload lots for commercial purposes generally. Effective April 1, 1920, Docket No. 3666, the Interstate Commerce Commission provided for carload shipments of one ton containers in paragraph 1861a, as amended, of the Regulations for the Transportation of Explosives and Other Dangerous Articles by Freight and Express Including Specifications for Shipping Containers, viz.:

All compressed gases must be shipped in metal cylinders. Provided that chlorine and sulphur dioxide may also be shipped in special tank cars complying with Master Car Builders' Specifications for tank cars for these commodities. Provided further, that chlorine, sulphur dioxide and methyl chloride may be transported in cylinders manufactured and reported in full compliance with B. E. Specification No. 27 effective March 1, 1918, or I. C. C. Specification No. 27 effective April 1, 1920, and loaded on special cradles bolted to cars, if the shipment is loaded by the consignor and to be unloaded by the consignee, under the following conditions: The cars used must be gondola cars with continuous steel center sills preferably all steel underframe, and with wooden floors without drop doors; the plan for construction of the cradles and the methods of bolting to cars as adopted by any shipper must be approved by the Bureau of Explosives; the cylinders must be fitted with safety devices in accordance with paragraph 1862 of these regulations; the marking on the cylinders as required by the specifications must be of such size and so located that it can be easily read by a person on the ground after the cylinders are loaded on the cars, except that a reproduction of the marking on a plate so as to fully comply with this requirement will be permitted.

TON CONTAINER

This one ton chlorine container is now covered by I. C. C. Shipping Container Specification No. 27, Revised January 1, 1923, and Amendments Thereto.

In effect the specification provides for a container eighty inches long overall; thirty inches external diameter; wall thickness 0.375

inch; head thickness 0.75 inch, of open hearth steel containing not more than 0.20 per cent carbon, 0.04 per cent phosphorus and 0.05 per cent sulphur. It is also provided that

All joints and seams shall be made by the forge-lap-weld process and thoroughly hammered or rolled to insure a perfect weld. The heads of the cylinders, except when they form a part of a seamless shell, shall be flanged not less than 4 inches and dished concave under a red heat to a radius equal to the diameter of the shell. They shall be inserted into the shell with flange extending outward and shall have a snug driving fit into the shell. The projecting flanges must be forge-lap-welded to the shell and then crimped inwardly toward the axis line not less than 1 inch on the radius. The welding and crimping of each end to be accomplished in one heat.

The container weighs 1300 pounds; has a water capacity of 1600 pounds and the permitted chlorine loading is 1.25 pounds of liquefied chlorine gas per pound of water, i.e. 2000 pounds. The loading occupies approximately 80 per cent of the container capacity with the liquefied chlorine gas at 68°F. thus allowing for expansion if the temperature is pushed upward.

It is also provided that

Valves and other connections must be made safe from injury during transit by being set into the recessed heads of the cylinder and completely covered by a steel cap. The cap must be made of material at least $\frac{3}{16}$ inch thick; it must not project beyond the flanged ends of the cylinder; and it must be fastened in place by positive fastenings so that it will not come off during transit and so that a blow will not jam it up against the valves or connections.

There are two valves, both in the same head. The loaded containers are always set in the cradles of the car frame in one way, and that way always brings the valve parts at right angles to the length of the container. The two eduction pipes are made of extra heavy $\frac{3}{8}$ inch wrought iron pipe fused into valve bosses made of $1\frac{3}{4}$ inch cold rolled steel shafting and provided with a $\frac{3}{4}$ inch standard pipe thread. These pipes are curved to conform to the shape of the concave head and lie adjacent to the head but do not touch it, and end very close to the sides of the container. Each finished cylinder must be subjected to not less than 500 pounds hydrostatic pressure; must have a regulation identity plate on it; the owner must hold specific approval for each container in interstate commerce; must equip each cylinder with approved fusible plug safety devices; and must supply at his own expense a competent and disinterested inspector who is required to make rigorous tests and certifications of both raw ma-

terials and finished cylinders, for the Bureau of Explosives, and, furthermore, a quinquennial pressure test is required. The safety plugs before referred to are six in number, three in each head and so staggered that three are always below the surface of the liquid contents of the container, and are fusible at 160° to 175°F. At 68°F. temperature the interior pressure in a loaded cylinder is 97.31 pounds per square inch and at 176°F. is 417.48 pounds per square inch, so that there is an ample margin of safety from cylinder ruptures in the event of the undue heating of the cylinder from fire or steam.

As is the case with all containers and their valves, there is a meticulous inspection at the chlorine plant of every ton container; inside and out, before loading, and equally careful outside inspection of each loaded container before shipping.

ONE TON CONTAINER CAR

The aforementioned order of the Interstate Commerce Commission provided for the mounting of fifteen of these one ton containers on a special car frame previously approved by the Bureau of Explosives, the Tank Car Committee of the American Railway Association and the Bureau of Safety of the Interstate Commerce Commission. The first of these cars was put into commerce on January 6, 1922, by Mathieson Alkali Works (Inc.), patentees of special features of the car (U. S. Patents 1,453,475, 1,453,476, and 1,458,588 and others pending). This company has generously made it possible for other chlorine makers to use this type of car. Under a decision of the Interstate Commerce Commission, Docket 2456, effective November 9, 1925, it was ruled that such cars shall be classified and entitled to rates (based on 30,000 pounds maximum loading) prevailing on Class V cars, i.e., tank cars, provided the full complement of cylinders is securely attached to the car underframe whether loaded or empty. This car, known in the chlorine industry as the "multiple unit tank car," is increasingly in use by a number of chlorine manufacturers and is a distinct and valuable contribution to the technic of both producer and consumer of liquefied chlorine gas.

The car admits of three ways of horizontal unloading of liquefied chlorine gas, viz., piping each container separately, piping 15 containers through a car manifold, or the removal of all 15 containers to storage and replacement of 15 empty containers to the car frame.

If the containers be removed and set on end, gas and not liquefied chlorine gas will flow through the valves when discharging.

The ton container makes chlorine storage and use highly flexible and reduces connections by the ratio of 1 for 13 in the case of a consumer who is in the carload class of consumer and cannot well handle Class V cars. Over 100 of these cars are now in use, and they are also coming into service in the shipment of liquid sulphur dioxide.

FREIGHT CHARGES

A 30,000-pound minimum carload of liquefied chlorine gas would require 300 of the 100-pound cylinders or 200 of the 150-pound cylinders. In the first case you pay freight on 27,900 pounds of container as well as on the chlorine, and in the second case on 24,000 pounds of container as well as on the chlorine. On the other hand, the multiple unit tank car pays the same freight rate on exactly 30,000 pounds of chlorine, and no freight on the containers. The car, laden with empty containers, is returned as a tank car without freight charges, thus wiping out heavy return freights on small cylinders. Furthermore, it costs the manufacturer of liquefied chlorine gas more to maintain and load small cylinders than one ton containers, and it follows, therefore, that the consumer receives the benefit of lower cost of chlorine from this cause as well as from the lower freight costs. These savings are appreciable. The first waterworks user (New York City at Ashokan, Kensico, Boiceville and Dunwoodie chlorinating stations) of the ton container recently estimated a net saving of $45.55 per ton of 2000 pounds, basis Ashokan freight rates and consumption. At these four New York City stations a very efficient handling technique has been developed and at least two more New York chlorinating stations are to be equipped to use ton containers. A somewhat more recent addition to the list of water works using the ton container is the plant at Berkeley, California. Los Angeles, California, is arranging to install the ton container.

USES OTHER THAN AT WATER WORKS

Aside from large water works, the ton container has come rapidly into use at paper mills, cotton bleacheries and hypochlorite plants, and recently at a large sewage disposal plant. Obviously the system for unloading and handling at one place is not necessarily the

way to proceed at another place, and accordingly the chlorine manufacturers provide expert service to adjust the ton container to the local situation.

Some very ingenious installations are now in use. For instance, at a large consuming point in a closely populated city district, the multiple unit car can be delivered on a private siding equipped with suitable derailers. An overhead crane with approved tackle removes the ton containers to an underground fireproof concrete storage that can be flooded with water. Alongside and above the car position is a large tank of caustic soda solution, and in the event of any serious escape of gas from containers on cars the caustic soda solution can be released by large valves so as to flood the car and absorb the gas. Such elaborate precautions are not necessary at remote water works and sewage disposal plants, but this installation is a good example of how to adapt the ton container to unusual conditions.

The arrangement of the heads and the frame gear permits the use of an approved simple and sturdy chain hook or straight bar with hooks. Loaded chlorine containers of all kinds should never be handled with makeshift slings, or tilted or dropped on trucks or rolled carelessly on temporary inclined planking and the like. Consumers should consult the chlorine manufacturers and get the benefit of their experience and advice both from a safety and dollars and cents standpoint. The North American chlorine industry has been remarkably free of accidents in handling this noxious gas and every possible safeguard should be had.

At paper mills the ton container is increasingly in use as it fits into their large scale operations easily and greatly increases the flexibility in supply and storage at plants remote from chlorine manufacture.

The ton container is also adaptable to the large scale operation of chlorination of petroleum, natural gas and ores, and to the export of chlorine to the West Indies and to Central and South America as the container can be readily loaded on steamer decks and the returning empties satisfy the requirements for a container complement. In domestic practice it is usual to start the installation by shipping twenty-four loaded ton containers in two gondola cars so as to provide a container complement on discharge of the first multiple unit car. This is the one and only time the ton container figures as a freight cost.

The use of the ton container at sewage disposal plants is an interesting development paralleling the general increase in the use of chlorine gas not only as a sterilizing agent but as an adjunct in practically every kind of sewage disposal now in use in North America. As sewage works are generally remote from densely populated districts and require more chlorine per million gallons than does potable water, the ton container is a vital factor in cost and efficiency of sewage chlorination. It is not suitable for very small operations and probably not for cases where a small amount of chlorine is added to raw sewage well ahead of sewage disposal works to delay septicity and prevent the formation of hydrogen sulphide and stenches, without harm to the subsequent disposal methods. In fair sized sewage plants the ton container has a place and is now in use.

CONCLUSION

Chlorine is unlikely to be made at the point of consumption unless the quantity used is considerable, unless salt and power are cheaply available, and the two inevitable and additional products of the electrolytic decomposition of sodium chloride solutions, namely caustic soda and hydrogen, have nearby uses in a coördinated economic scheme. Under such conditions, chlorine must be cheap. To be cheap it must have suitable points of manufacture, large scale production and a variety of uses. The ton container is therefore a distinct and valuable contribution to the art of handling liquefied chlorine gas, and of great use to both maker and user.

Those contemplating ton container use should carefully figure all costs and avail themselves of the experience and counsel of the chlorine makers.

GROUNDING ELECTRIC CIRCUITS ON PIPES[1]

By Charles F. Meyerherm[2]

The question of grounding electric circuits to water pipes was brought forward for consideration in view of a possible revision of the National Electric Code. This was also taken up by a special Committee in conjunction with the New England Water Works Association. The danger of electrolysis and other hazards incidental to the grounding of electric light circuits to water pipes in accordance with the present requirements of the National Electric Code was given consideration. It was also felt that the position taken by this Association on grounding required revision in view of certain marked changes in the construction of electric and water distribution systems. While no definite action has been taken as yet by these Committees it was felt a report or paper should be prepared advising you of the conditions now existing so as to prepare you for such action as the future may demand.

After considerable correspondence, a meeting of those members of the Research Sub-committee who were interested in the grounding problem was arranged, at which meeting Mr. Blood, Chairman of the Grounding Committee of the National Fire Protection Association, was invited to be present. At this meeting representatives of the American and New England Water Works Association pointed out to Mr. Blood the difficulty which had been experienced with present grounding methods. Employees of water companies, in handling meters and service connections, had suffered severe electrical shocks from currents on these water pipes due to grounded lighting or power circuits. Stray railway currents of large magnitude had been found flowing over the electric light ground wires and specifically installed measures of electrolysis mitigation had been nullified by electric light ground wires. In certain cases where insulating joints had been installed in water service pipes at the main and in the house the connection of electric light ground wires

[1] Presented before the Chicago Convention, June 9, 1927.

[2] President, Albert F. Ganz Company, Inc., New York, N. Y.

to the water service pipe outside of the house insulating joint had resulted in the destruction of these service pipes by stray railway current delivered by the ground wire.

PRESENT AND FUTURE PRACTICE WITH INSULATING JOINTS

To obtain information on the present and future prevalence in water systems of non-metallic pipe and insulating or high-resistance joints in mains and services, a questionnaire was prepared and sent to members of the American and New England Water Works Associations.

This questionnaire covered materials used for existing mains and for services, and approximately how many miles of each material was in service in mains. It also asked what types of joints were used in existing mains and services, and where and how frequently insulating joints were installed in existing mains and services. It asked where the insulating joints in service pipes are located with reference to the building supplied, and what percentage of the existing services contained insulating joints. The final question on existing plant covered the location of meters, what percentage of the meters were located in buildings, and what percentage were located at the curb or outside of buildings. Similar questions were asked regarding new plant and the questionnaire concluded with a request for general recommendations and information regarding trouble experienced with the grounding of electric light and power systems on water pipes.

The American Water Works Association received 108 replies, while the New England Water Works Association received 59. The information obtained from these answers was summarized and tabulated, and on account of its general interest and value is presented herewith as table 1. From table 1 in the section under existing plant, the answers to the questions regarding the kind and amount of various pipe materials in actual service show about 24,500 miles of cast-iron mains, about 1700 miles of galvanized iron, steel or wrought-iron mains, and about 100 miles of cement, wood or other non-metallic pipe. In regard to materials used for existing services the replies show an extremely wide variety, all services however were metallic in nature.

TABLE 1

Digest of information contained in replies to A. W. W. A. and N. E. W. W. A. Questionnaire

		NUMBER OF SYSTEMS	PER CENT OF SYSTEMS
Information on existing plants			
Material in mains:			
All metallic mains		138	90.8
Some non-metallic mains		14	9.2
Total miles of cast iron mains (approximately)	24,500		
Total miles of other ferrous mains	1,700		
Total miles of non-metallic mains	100		
Types of joints:			
In mains:			
All electrically conducting		95	62.5
Some leadite, cement or other high resistance material		56	36.8
Use of special insulating joints:			
In mains at some points		6	3.9
In services at some points		3	2.0
Meter location:			
All meters inside buildings		56	37.6
All meters outside buildings		27	18.1
Some meters inside and some outside buildings		66	44.3
Total meters inside buildings	72.0%		
Total meters outside buildings	28.0%		
Information on new plants			
Material in Mains:			
All metallic mains		152	100
Types of joints:			
In mains:			
All electrically conducting		74	48.7
All leadite, cement or other high resistance material		32	21.0
Some leadite, cement or other high-resistance material		21	13.8
Use of special insulating joints:			
In mains at some points		4	2.6
In services at some points		4	2.6
Grounding and electrolysis troubles			
Reports of trouble from grounding:			
A. C. Circuits		12	7.9
D. C. Circuits		5	3.3
Reports of no trouble from grounding		116	76.3
Reports of existing electrolysis trouble		35	23.0
Reports of past electrolysis trouble, apparently remedied at present		11	7.2

TYPES OF JOINT MATERIAL IN USE

In considering the type of joint material used either from the electrolysis or the grounding standpoint, two main subdivisions are significant, namely, metallic materials whose use results in electrically conductive joints, and non-metallic materials whose use results in joints having a high electrical resistance. According to the answers received approximately 62.5 per cent of the water works systems have used nothing but lead or otherwise electrically conducting joints in existing mains, while 36.8 per cent have used varying amounts of leadite or other similar material having a relatively high electrical resistance. For new work, the use of all lead joints shows a definite decline, because only 48.7 per cent of the replies stated that they expected to use all lead joints, 21.1 per cent stated that they expected to use all leadite or similar high resistance material, and 13.8 per cent expected to use some of each of the above types.

LIMITED USE OF INSULATING JOINTS

The use of actual insulating joints in mains or services appears to be restricted entirely to a few companies who have had considerable experience with stray current electrolysis and its mitigation, and have adopted a definite engineering policy covering electrolysis testing and mitigation. Only 6 companies reported that they had used insulating joints as required in mains, and 3 companies in services. Four companies stated that they expected to use insulating joints in both new mains and new services where electrolysis conditions demanded such protection.

LOCATION OF WATER METERS

From the grounding standpoint, the location of the water meters is important because, in the case of meters located inside of buildings, the ground connection can be attached to the pipes on the street side of the meter, while with meters located outside of the building a removal of the water meter for any cause may nullify the effect of the ground connection and result in hazard to life and property. For this reason copper wire shunts have frequently been required around all water meters where the electric light ground connection of necessity is attached to the piping on the house side of the water meter. The replies to the present questionnaire indi-

cate that 37.6 per cent of the companies have all of their meters located inside of buildings, 18.1 per cent have all of their meters located outside, and 44.3 have their meters located both inside and outside. From the actual figures on the percentage inside and out, as given in the replies to the questionnaire, it would appear that 72 per cent of all of the water meters are located inside of buildings and that 28 per cent are located outside. For new work 54 per cent of the replies stated that they plan to install all meters inside of buildings, 18 per cent stated that they plan to install all meters outside of buildings, and 28 per cent expected to use both methods.

GROUNDING OF CIRCUITS ON WATER PIPES

Regarding the last two items of the questionnaire 76.3 per cent of the replies stated that they had experienced no trouble with the grounding of electrical circuits on water pipes, 7.9 per cent reported trouble from the grounding of alternating-current circuits, 3.3 per cent reported trouble from the grounding of direct-current circuits, and 12.5 per cent expressed no opinion either way. In this connection it is interesting to note that, although not specifically requested to do so in the questionnaire, 23 per cent of the replies included a statement that they were actually having electrolysis trouble at the present time, and 7.2 per cent reported that they had had electrolysis troubles in the past, but that the difficulty had been remedied.

From the foregoing summary of the results of the questionnaire it will be seen that a substantial number (11.2 per cent) of water works operators are actually experiencing trouble from the grounding of electrical circuits on the water pipes, and this would certainly seem to justify reconsideration of the question of grounding electrical circuits on water pipes by the Grounding Committee of the National Electrical Code. So long as no appreciable current flows over the ground connections under normal operation, or for appreciable lengths of time during abnormal operating conditions, there is no reason to prohibit or restrict the use of this method of protection as a general safety measure. Where, however, disadvantages or hazards exist, or the grounding of electrical circuits can be shown to be detrimental to the pipes, such grounding should not be permitted.

The replies to the present grounding questionnaire definitely show the existence of a large amount of pipe laid with high-resistance joints, and the existence of a small amount of non-metallic pipe, and of some instances where insulating joints exist in water mains and

services. In the latter case, the electrolysis problem has forced the water company to spend time, money and effort in testing and applying mitigative measures, to protect their structures and their facilities for supplying a public necessity. It certainly seems unreasonable to assume that in granting permission to ground electric circuits to water pipes for protection in the event of disturbances on the electrical system, the water works operators had surrendered any rights to their own property, or subordinated the use of their structures as water pipes to their use as electrical conductors.

The use of non-metallic joint material is on the increase, while the use of non-metallic pipe and of actual insulating joints will probably continue on new work at about the same rate that it exists in old plants. It is therefore very evident that, from the standpoint of general public safety, a water piping system cannot arbitrarily be assumed to be a continuous metallic conductor. It is true that, generally speaking, the existence of high-resistance joints or possibly insulating joints in water mains will not materially affect the effectiveness of a ground connection as a protection inside the building where such connection is made, but, in the event of substantial current flow over such a water piping system, such joints will cause a marked building up of electrical potential across them and set up a distinct hazard to such pipes and to all persons having to work on them when such potential differences exist. If the potentials are due to momentary disturbances of the electric system they will involve hazard only during relatively short intervals, but if during normal operation substantial current flow occurs over the ground connections, due to disturbances or unbalances of the electric system which are not serious enough to operate the circuit protective equipment, the hazards may prevail for a considerable period, probably until an actual accident occurs.

THE SO-CALLED MULTI-GROUNDED COMMON NEUTRAL SYSTEM

Just recently the attention of your representatives has been called to the so-called multi-grounded common neutral system of electric power distribution which constitutes a serious electrical hazard and an unwarranted use of the piping systems as electrical conductors. The method has been used to some extent in Minneapolis, New Orleans, Omaha, and some other western cities and seems to be coming into vogue in other places. It involves a neutral conductor grid which extends throughout the secondary distribution network; and

to this grid the neutrals of the primary supply circuits are also connected. In each house having electric service the neutral wire is grounded to the water pipes by a direct metallic connection, and at the primary current supply points, the primary transformer neutrals are also grounded to the water pipes.

In this way the water piping system is electrically in parallel with the primary supply system, in addition to the secondary distribution system. In accordance with the law of divided circuits, the water pipes will under the foregoing conditions, normally carry shunting currents whose magnitudes will depend upon the resistance and impedance of the water pipe circuit. Even under normal operating conditions large amounts of alternating current can thus flow over the water pipes and the potential of the pipes at outlying points will be raised to the extent of the voltage drop produced by the current flow. In case of serious unbalance on the primary distribution system extremely large currents may flow over the water pipes and serious fire and life hazards may be set up in houses and also in the street at high resistance or insulating joints, or if lines have to be cut for repair work. These hazards will exist not only during short-time periods required for the functioning of the protective devices but they may exist undiscovered for long periods, because as already explained the shunting currents need not represent serious disturbance of the electric system.

In the multi-grounded common neutral system, the neutral conductor is generally made smaller than the ungrounded conductors, and this definitely shows that the pipes are expected to carry current. As a matter of fact the entire circuit arrangement affords no advantage to the electric light company unless the pipes do carry current under normal operation. This fact, together with the hazards already enumerated, have caused a good many electric distribution engineers to condemn the multi-grounded common neutral system as improper and hazardous.

Metallically connecting the water pipes at numerous places to metallically continuous grid also increases the difficulty and expense of testing, supervising and correcting stray railway current electrolysis conditions. It absolutely nullifies the beneficial effect of any insulating joints which may be installed in the pipe line for electrolytic protection.

In conclusion, your committee would point out that, as far as water works operators are concerned, the present offers just as many

reasons as the past for an active and aggressive policy in connection with electrolysis matters, and in connection with the grounding of electrical distribution systems on pipes. The fact that a comparatively large number of leadite or other high-resistance pipe joints are already in service, and that about 20 per cent of the water works operators are planning to use this type of joint material exclusively, while an additional 14 per cent will use it to a greater or less extent in conjunction with ordinary lead joints, indicates definitely additional serious complications and hazards particularly if such metallically discontinuous pipes are used as electrical conductors for stray electric currents either from power and light or railway systems.

Your Committee would also point out that in using leadite, lead hydrotite, or other non-metallic jointing material in making repairs to existing pipe lines, it is important to know whether or not these pipe lines are carrying appreciable stray current; and, if they are, whether interrupting their electrical continuity with a few isolated non-metallic joints will cause the setting up of dangerous potential differences across such isolated joints. Water works operators should appreciate the fact that the introduction of a few non-metallic joints in an otherwise electrically continuous pipe line which is carrying stray current may set up serious corrosion of the pipe due to the current shunting through earth around the joint.

WATER TREATMENT AND RAILROAD EFFICIENCY[1]

By E. M. Grime[2]

The efficiency of American railways has been increased to a remarkable extent during the past ten or fifteen years. This has not been brought about in any great measure by the construction of additional lines to open up new territory, but by large expenditures to improve existing facilities so as to give better service at less cost. Every feature of railway operation has been scrutinized and changes made wherever a saving could be shown, either in time or operating costs. Not the least of the savings accomplished in this manner has been by the lengthening of locomotive runs. Where it was formerly the custom to operate over a one hundred or one hundred and fifty mile district and then put the locomotive into a house where it was inspected, cleaned, and repaired if necessary, now it is run two hundred, five hundred, or in some cases as far as nine hundred miles at a stretch requiring little more attention than was formerly considered necessary for the shorter runs.

In those cases where the water supply is of very poor quality the accumulation of scale and the concentration of soluble salts may still make it desirable to wash the boiler at the end of a two hundred mile run, but the longer runs are now successfully made in naturally good water territory and also equally well in those districts where, through the skill of the engineer and the chemist, very poor waters have been treated in such a way as to make them practically equal to the best of natural waters. On railways where bad water conditions still exist it has been stated that the correction of this condition promises a larger return on the required capital investment than any other improvement that now remains to be made.

The development of railway water supply facilities has been gradual and naturally followed the increase of traffic. In early days when locomotives were small, a wayside tank holding about seven

[1] Presented before the Boiler Feed Water Studies Session, Chicago Convention, June 8, 1927.

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thousand gallons was ample and the most primitive methods of pumping answered the purpose, whereas today highly efficient pumping plants, one hundred thousand gallon storage tanks, and water columns delivering a flow of three thousand to five thousand gallons per minute are demanded as a necessity to serve the modern locomotive. Each minute of time that can be saved has a definite value, and on eastern lines of dense traffic, the rather costly open water track pan which permits the filling of tenders without even a stop is justified.

In early days the quality of the water received little attention and almost anything that was wet answered the purpose, but it was not long before certain waters were found to cause serious trouble by foaming and also to fill up the water spaces with a hard scale which it became increasingly difficult to remove. Various substances known as boiler compounds were tried in an effort to overcome this trouble, but as the natural waters in a given district invariably differ in quality, what may be a help with one is not satisfactory for another water and so little was gained by this method of internal boiler water treatment. European railways were the first to investigate methods for improving poor boiler water, but not much was accomplished until in 1841, Clark, of Scotland, successfully used lime to precipitate the carbonates of lime and magnesium and a few years later, Porter, an Englishman, suggested the use of soda ash to decompose the lime and magnesium sulphates. A combination of these two methods for treatment of the water before it entered the boiler was soon worked out. On account of the simplicity of the process and the comparatively low cost of the chemicals involved this method has become the basis for most water softening processes as used on railways.

The desirability of using properly softened water for locomotives became more apparent as railway traffic increased, larger locomotives were put into service and the working conditions became more severe. In aggravated cases locomotive boiler tubes would last only six months and the dropping of crown sheets due to overheating by reason of the insulating effect of heavy scale deposits was not uncommon. Leaky flues would necessitate the attention of boiler makers after every trip, and a combination of these troubles with foaming due to concentrated alkali salts contributed to serious operating difficulties.

Experiments with the use of water softened by the lime-soda pro-

cess indicated that the life of tubes could be considerably increased and boiler repairs materially reduced. This gave quite an impetus to the adoption of methods for treating the water at those locations where it was not possible to find a suitable natural soft water. It is now recognized that to secure efficient results all the water on a given engine district should be softened in order to secure approximately uniform quality. In 1904 the Water Committee of the American Railway Engineering Association reported that 27 railways had been found to have installed water treating plants and in 1905 fifteen others were following the same course and there was no longer any question as to the beneficial results being accomplished. It was found that, as the water was improved, boilermaker forces could be gradually decreased and that the savings to be accomplished were worth while, not only on this account, but also by reason of the shorter time the locomotive was held out of service and the very large improvement in train operation.

SAVINGS DUE TO WATER TREATMENT

Some of the savings accomplished were found difficult to capitalize, but it seemed desirable to arrive at definite data by which to measure the losses due to the use of bad water and the capital expenditure that would be justified to purify a given supply. The Water Service Committee referred to made a careful analysis of these losses in 1914 and came to the conclusion that the damage caused by the accumulation in a locomotive boiler of one pound of scale forming material amounted to 7 cents. Since that time, on account of the increased cost of everything that enters into the calculation, it has been found proper to increase this figure to 13 cents. Stated in other terms each grain of hardnesss in a bad water does a damage of $0.0186 per one thousand gallons of water evaporated. It is realized that a hard sulphate scale will be more injurious than the same thickness of soft carbonate scale, but usually there is a mixture of the two in varying quantities. At the same time there are other elements to be taken into account besides simply the insulating effects due to the scale, and this figure is therefore taken as an average value sufficiently accurate for practical purposes.

That this is very conservative is shown by the fact that the actual losses as determined by the cost of locomotive maintenance in a bad water territory compared with costs in a good water territory show up much higher than may be determined by the thirteen cent figure.

On a leading Eastern railway where the water quality can hardly be considered as being in the very poor class, a careful study of boiler maintenance and fuel costs shows that the annual loss due to bad water on its lines amounts to over $3,000,000 and that in every case the actual loss exceeds what would be indicated by the use of this A. R. E. A. rule. With this as a basis it is not uncommon to find that the savings to be anticipated by reason of boiler feed water treatment are annually twenty-five to fifty per cent of the total amount of the capital expenditure required for construction of water treating facilities. If doubt should still exist as to the correctness of evaluating scale accumulation damage in this manner, on a railway which has both good and bad water territory, a study of the statistics showing the cost of locomotive maintenance per mile may fairly indicate some measure of the damage done by bad water. All other conditions, such as type of locomotive, ruling grades, tonnage, and other operating details being substantially the same, a cost for locomotive maintenance in a certain district regularly exceeding the average cost for this item will show to what extent bad water is interfering with efficient operation. A comparison recently made in this way showed an excess locomotive maintenance cost on a bad water division of $215,000 per annum as compared with an annual loss of $105,000 computed on the 13 cent basis. The improvements suggested as necessary to eliminate this $105,000 are estimated to cost $362,000 and the correction of this condition will therefore show a saving of twenty-nine per cent on the investment.

PITTING AND CORROSION

As a rule the damage done by reason of the accumulation of scale is most apparent in the necessity for washing of boilers at short intervals, of excessive repairs to tubes, flues, and fire boxes, and in fuel losses; but on most Western railways, aside from these difficulties, we have a serious problem in the matter of pitting and corrosion which causes the scrapping of tubes and sheets in but a fraction of what should be their useful life. Some have held that a coating of scale seems to be a protection against corrosion, but in most cases when sulphates of the alkali metal group are present as well as alkali sulphates and the water is thus a good electrolyte, corrosion takes place regardless of the scale. Pits will develop underneath the hardest kind of scale coating and will eventually pierce the metal, causing failure of the tube. Where some kind of internal boiler

water treatment is resorted to, causing partial removal of the scale· the pits may be scattered over a wider area and not penetrate the tube quite so quickly. It is now usually conceded that this pitting is due to electrolytic action made possible because the boiler water is a good medium for the passage of minute electric currents between points of differing potential on the surface of the metal. The metal of the tube or shell is dissolved at the anode while hydrogen is plated out at the cathode. Mr. Speller has observed that the smaller the anodic areas with relation to the cathodic, the greater will be the rate of corrosion at the anodic points and therefore the greater tendency to form small holes or pits. This apparently explains the early pitting through of the tube where scale is dense or mostly of the hard sulphate kind as compared with more uniform corrosion, but slower complete penetration, where scale is of the soft carbonate variety.

The Water Service Committee of the American Railway Engineering Association, after conducting extensive tests, arrived at the conclusion that waters which are good electrolytes can be deprived of this quality by adding in the treating process sufficient excess lime and soda to create a sodium hydrate alkalinity. The rule is

$$\frac{\text{Grains sodium sulphate} + \text{grains sodium chloride}}{10} + X$$

equals the grains sodium hydrate necessary to inhibit corrosion. X is a variable covering constituents in the water other than sodium sulphate and sodium chloride. For distilled water X becomes 5, but in the presence of carbonates or hydrates of calcium and magnesium it can probably be disregarded.

In the arid regions of the West many deep well waters are found which contain a large amount of alkali sulphate, but fortunately they frequently also contain sodium carbonate and evidently the latter, under boiler conditions, forms sufficient caustic to act as an inhibitor. It is not unusual to find stationary boilers using such water that have been in service for fifteen to thirty years with practically no corrosion trouble. If any incrustation is seen, it is around hand hole plates where a slight amount of leakage and evaporation has left a rim of caustic soda crystals. A prominent railway is now utilizing these natural deep well alkali sulphate and carbonate waters over an entire engine district, and so far the reports indicate large savings in boiler maintenance costs with no serious foaming troubles and no corrosion.

DEAERATION

It seems evident that corrosion in a locomotive boiler will not continue unless oxygen is present in the water to take up the hydrogen which collects on the cathodic areas and which would otherwise, by its polarizing effect, tend to stop the flow of current. It seems most desirable therefore to eliminate from the feed water as much as possible of the uncombined oxygen. Working on this theory, the open feed water heater which gives the oxygen a chance to escape before the water enters the boiler should materially improve conditions. Experiments to determine this are now in progress on several railways. Where conditions are such that heaters of this type can be used exclusively and kept in proper working order, so far they appear to accomplish definite results in the way of decreasing corrosion. As yet it cannot be said that the experiments are conclusive, but this method of increasing locomotive efficiency will be watched with interest.

EXPERIENCE ON CHICAGO AND ALTON RAILWAY

This polarizing effect of hydrogen which tends to stop the passage of the electric current has been utilized by Mr. Gunderson in some interesting experiments on the Chicago and Alton Railway. By means of two electrodes (anodes) introduced into the boiler below the water line, one at the upper right and the other at the lower left side, extending nearly the full length and perfectly insulated from the boiler shell, a positive charge of electricity amounting to ten amperes for each electrode is taken from the headlight generator and is passed through the water (the electrolyte) into the tubes and boiler shell, thus making every part that might be subject to corrosion cathodic instead of anodic. In addition to this counter electric current, and in order to further prevent the passage of a minute current from one point on the metal to an adjacent point, a so-called secondary cathode is created by adding to the boiler water once every thirty days one pound of sodium arsenate which immediately plates out on the boiler shell and tubes, and by reason of its high discharge potential for hydrogen, assists in holding the hydrogen film which would otherwise be more readily removed by combination with any free oxygen present in the boiler water. Boilers in which this method has been used are almost entirely free from corrosion, whereas others in the same territory and under similar working

conditions have a very brief tube life. For waters where scaling conditions are not serious or where soda ash treatment alone will hold down scale accumulation to the minimum, this counter electrical method promises a large increase in locomotive efficiency.

CHOICE OF TREATMENT METHOD

There are so many factors entering into the treatment of boiler feed water for railway uses that the problem actually becomes somewhat complex and requires careful study in order to select for given conditions the best method of treatment to secure the greatest measure of efficiency. The lime-soda treatment for waters high in the sulphates of lime and magnesium tends to increase the so-called foaming salts and thereby, above certain limits, to add to the difficulties of operation. In his efforts to provide a water free from harmful physical effects and thereby reduce the cost per mile of locomotive maintenance, the water engineer therefore faces the objections of some operating men who fear the slightest foaming trouble which may contribute to traffic delays. We are not certain as to the exact cause of foaming, but it can be shown that a large concentration of sodium salts will not cause foaming, if there is no insoluble or colloidal material present in suspension. Evidently it takes a combination of the above to cause foaming and the density of the dissolved salts as well as the character of the suspended matter also has some bearing. In any event this matter presents difficulties that require constant attention. When treatment is first started and the boilers have not yet become thoroughly freed of scale, in order to have smooth operating conditions, a limited amount of some good anti-foam compound may be found desirable. The basis of these anti-foam compounds is castor oil and experiments have shown that 1 pint of this substance to 5000 gallons of boiler water will hold down a raw water containing as high as 125 grains per gallon of sodium sulphate and 20 grains of insoluble precipitates. Its careful use with a well treated water should therefore solve any foaming troubles. As a rule after water treatment has been in use for a time, if all waters in an operating district are properly softened, the enginemen find they can get along without the compound. The period required to attain this condition will depend on how long it takes to get the boilers thoroughly clean so there is no longer finely divided insoluble material remaining to aggravate foaming. Under these conditions a moderate amount of blowing down combined with the

moderate use of anti-foam compound constitute the ideal operation for greatest efficiency. While the water engineer is interested in a water perfect as far as corrosion and non-scaling qualities are concerned, he cannot lose sight of the fact that the railroad is operated primarily to move traffic and everything else must be secondary to having trains move without delay. Foaming conditions which cannot be controlled with reasonable precautions must therefore be avoided by securing a better water supply even though this may involve considerable expense.

ZEOLITE METHOD OF WATER SOFTENING

A discussion of increased efficiency by reason of boiler feed water treatment would not be complete without mention of the zeolite method of water softening. Zeolite mineral or green sand is a base exchange silicate which has been successfully used for water softening in the industries for a number of years and is now being tried out for railroad use on the Pacific Coast where water conditions are suitable and common salt can be purchased at a favorable price.

The increase in sodium salts by this method makes it desirable to have a raw water low in sodium chloride or sulphate and the less calcium or magnesium bicarbonate, the better. While the lime-soda process removes the calcium and magnesium carbonates, the zeolite simply changes them to sodium carbonates. Zeolite treatment thus increases the soluble solids over ordinary lime-soda treatment, but this is about offset by the excess treatment often required in the lime-soda process in order to secure complete softening and a caustic quality sufficient to inhibit corrosion. While it has not yet been definitely proven, it seems probable that the sodium carbonate produced by the removal of carbonate hardness will, under boiler conditions, change to caustic at a sufficiently rapid rate to inhibit the corrosive tendencies of any sodium sulphate which may be present. For most places in the interior of the country the price of salt is such that for the removal of carbonates lime is a cheaper chemical than salt, while for the removal of sulphates salt is a cheaper chemical than soda ash. For some situations a combination of lime treatment to first remove part of the carbonates and the zeolite to change the sulphates will work out to advantage. After-precipitation in long pipe lines is sometimes a problem with lime-soda softeners and this trouble is not present with zeolite treatment. Zeolite by-products are soluble, making this type of treatment often

advantageous where the disposal of sludge from a lime-soda plant would be a serious problem. The operation of a zeolite plant is simple and it does not require that close technical attention necessary for regulation of a lime-soda plant.

USE OF SODIUM ALUMINATE

One of the principal advantages of the base exchange method is the reduction of hardness to one grain or less, a result difficult to secure by the lime-soda process without using a considerable excess of reagents. It is, therefore, worthy of mention that, where the lime-soda process is in use, by the addition of sodium aluminate the hardness in many cases is being brought down as low as one grain, giving a treated water, which in respect to total solids may be superior to water treated by the zeolite method. Sodium aluminate by an improved process is now being manufactured in the dry form, making it very convenient for handling. Its use is now adding materially to the efficient operation of many water treating plants. When added during the treating process it forms a heavy floc which as it settles has a filtering effect that entangles or drags down the finer particles of precipitate formed by the chemical reactions and gives a perfectly clear water in minimum settling time. During cold weather especially, certain waters, which will not settle out clear for an indefinite period and still remain three or four grains hard, when thoroughly agitated with sodium aluminate solution, will clarify in thirty minutes or less and drop to a hardness between one and two grains. The claim is made that, by the use of this material, the excess treatment with lime and soda, often necessary to bring down the hardness of certain waters, can be avoided to a large extent. This can only be proven by actual tests with each kind of water.

It may be said that a locomotive is only as good as its boiler. As long as steam remains the chief source of power for railroad operation, the condition of the boiler will be a prime factor in operating efficiency. The increasing competition from motor busses and waterways makes the need urgent for more powerful and efficient locomotives. With locomotives approaching what would appear to be their maximum size, the nearest development within reach is along the line of higher steam pressure. Increasing the rate of evaporation increases the rate of concentration of any impurities which may exist in the boiler water, as well as the scale accumulation. The corrosive tendencies then become more active and it is evident that

higher efficiency for the locomotive adds greatly to the necessity for securing perfectly pure water. This is in line with the tendency in stationary plant practice where water approaching zero hardness is now commonly demanded.

Water treatment is essentially an engineering problem. In order to produce the best results and increase the efficiency of the railway, each plant should be carefully considered with reference to its proper location for the best train operation, the availability and quality of the raw water supply as affecting treating costs, and the type of water treating facilities best adapted to satisfy all conditions.

NEW MIAMI, FLORIDA WATER SOFTENING PLANT[1]

By L. R. Howson[2]

The problem of supplying an adequate water supply for Miami, Florida, which changed from a village of approximately 3000 population in 1910 to a city of nearly 150,000 fifteen years later, has been an interesting and difficult one.

The solution has been unique in that the City of Miami, although served by a private water company, has itself developed an entirely new well supply, installed the largest well water softening plant in the country and is delivering the softened water to the private company for distribution.

The water supply has, from the beginning, been drawn from wells which are sunk into the limestone, which at Miami is a spongy appearing formation immediately underlying the sand surface. The original wells were located within close proximity of Biscayne Bay. The supply was hard and under heavy pumpage developed a brackish taste. As the city grew, additional wells were drilled to the west which under heavy draft also yielded a brackish water. The water supply has always been unsatisfactory in appearance, for it had a color of approximately 60, and in hardness.

The demands for increased service have been so great that the privately owned water company has been required to make large expenditures for extension of the distribution system and accordingly the betterment of the supply itself was not solved until 1925.

With the increased importance of Miami as a tourist center, the city officials became convinced of the necessity for having a better water supply. Mr. Ernest Cotton, Director of Public Service, made an investigation of the practicability of securing a new water supply at a location further removed from the ocean and the effect of salt water, and resulting from that investigation, the city decided to itself install a new supply near Hialeah, some seven miles west of the city, install there a water softening plant and pumping station and deliver

[1] Presented before the Chicago Convention, June 9, 1927.

[2] Of Alvord, Burdick & Howson, Consulting Engineers, Chicago, Ill.

the water through a long force main to reservoirs near the city. From these reservoirs it was planned to have the water distributed by the Company which would add to its bills a surcharge sufficient to cover the cost of operation and fixed charges on the new plant. This surcharge was to be turned over to the city.

The city voted a bond issue of $750,000 and authorized the construction of the wells and the softening plant.

The city proceeded to drill the wells and during May, 1924, engaged consulting engineers to design the water softening plant. In

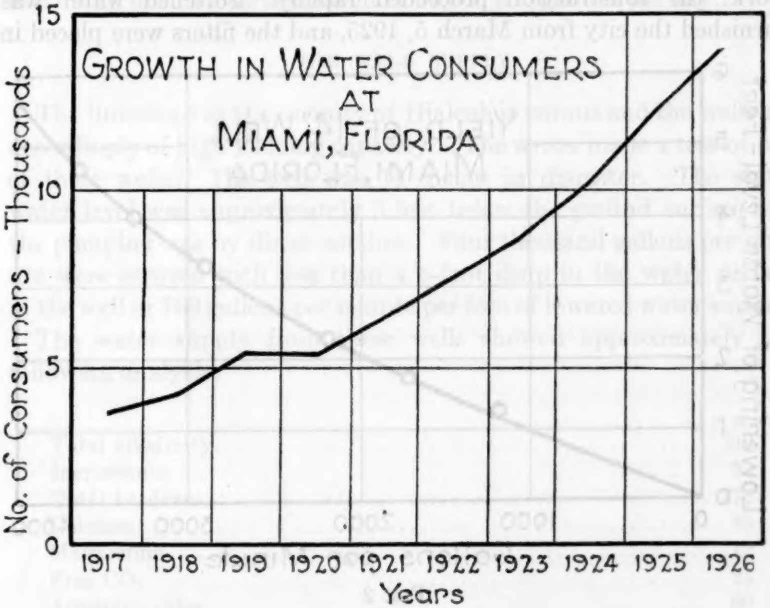

FIG. 1

view of the amount of the bond issue, it was decided to limit the initial construction to a capacity of 10,000,000 gallons per day, even though it was then apparent that practically by the time the plant would be completed, its capacity would be exceeded. It was, however, felt that with a first installation completed, and in successful operation, there would be no difficulty in securing the additional funds necessary to enlarge the plant.

Plans and specifications were rushed for the construction of a 10,000,000 gallon softening plant, and construction was started in

the late summer of 1924. At this time the Florida East Coast Railway had not built its double track line to Miami and the Seaboard Air Line was not built to the East Coast. Embargoes were in effect on many materials and contractors could not bid with any assurance as to costs or time of completion. The city therefore developed its own construction organization under Mr. Cotton and Mr. Jas. H. Cox, Engineer of Division of Water Supply, and proceeded with the construction. Aside from a delay of several weeks when the flood water from Lake Okechobee submerged the site of the work, the construction proceeded rapidly. Softened water was furnished the city from March 5, 1925, and the filters were placed in

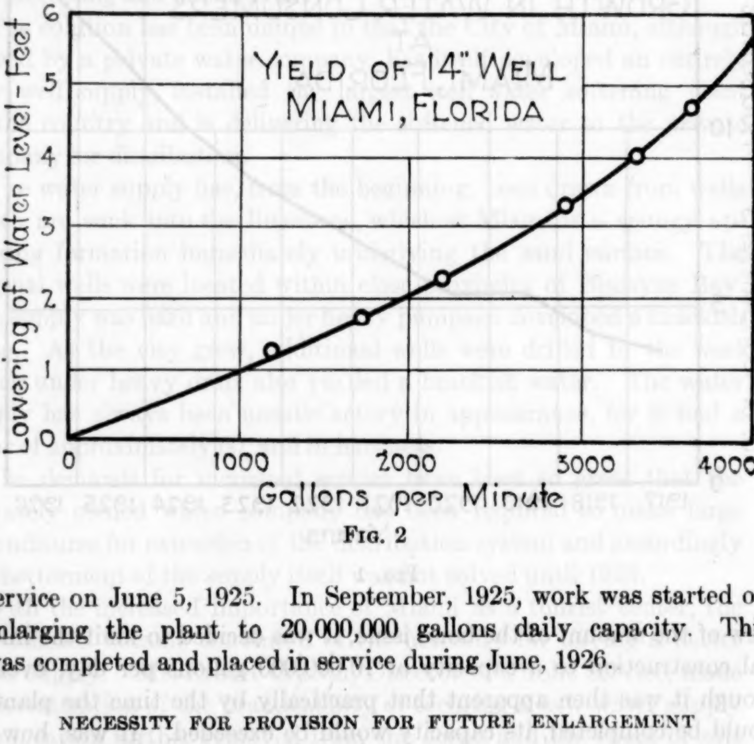

FIG. 2

service on June 5, 1925. In September, 1925, work was started on enlarging the plant to 20,000,000 gallons daily capacity. This was completed and placed in service during June, 1926.

NECESSITY FOR PROVISION FOR FUTURE ENLARGEMENT

With a development so rapid that the number of consumers has doubled approximately every 5 years and the water consumption paralleled this growth, it is manifestly difficult to predict with accuracy future growth. While a study of the past usually furnishes the best guide for the future, even the most optimistic would not

predict an indefinite continuance of the rate of growth which Miami was experiencing in 1924. It was decided, therefore, to build conservatively for the present, but to so lay out all improvements that they might be progressively enlarged without superseding any prior construction. While a plant capacity of 20,000,000 gallons per day would serve the immediate present, it was considered wise to design for an ultimate capacity of not less than 50,000,000 gallons per day. The arrangement of the plant and the layout of conduits and other structures was accordingly made with the idea of utilizing the plant site for an ultimate development of 50,000,000 gallons per day.

THE WELL SUPPLY

The limestone in the vicinity of Hialeah is porous and the wells are accordingly of high yielding capacity. The writer made a test of one of these wells. The well was 14 inches in diameter. The static water level was approximately 5 feet below the ground surface and the pumping was by direct suction. Four thousand gallons per minute were secured with less than a 6-foot drop in the water surface in the well or 700 gallons per minute per foot of lowered water surface.

The water supply from these wells showed approximately the following analysis:

	p. p. m.
Total alkalinity	219
Incrustants	53
Total hardness	272
Calcium	88
Magnesium	12
Free CO_2	25
Apparent color	60

In view of the character of the water which contained only about 50 parts per million of sulphate hardness, it was decided to adopt lime treatment only and reduce the hardness to approximately 90 parts per million, approximately half of which would be remaining carbonate hardness.

FIRST PLANT CONSTRUCTION

The first construction at the softening plant consisted of a chemical house with facilities for unloading and storing of chemicals, mixing tanks of the mechanically agitated type, primary settling basin with

a Dorr clarifier, a secondary plain settling basin, carbonating basin, filters, clear water basin and pumping equipment for the delivery of the water to the City.

Chemical house

The chemical house is a steel frame structure 27 feet by 42 feet in plan and about 60 feet in height. The steel frame work is inclosed by cement stucco on metal lath. The roof is of reinforced concrete slab construction on steel.

The chemicals at present are delivered to the chemical house by trucks which are dumped into a chute leading to the bottom of a bucket elevator of the grain elevator type. This elevator, operating in an inclosed steel shaft, conveys the lime or alum to steel bins which are standard steel tanks with hopper bottoms. The feed of the chemical from these tanks is entirely by gravity. The tanks store approximately 10,000 cubic feet or 200 tons of lime, a two weeks' supply for 15,000,000 gallons daily output.

From the storage tanks the lime passes by gravity through a weigh hopper having a capacity of 2000 pounds thence through a rotary measuring apparatus to a slaker directly underneath and thence to the solution tanks which are of the International revolving paddle type and which are located directly underneath the lime slaker.

It has been found practicable to operate the solution tanks with a very thick lime solution. In each three thousand gallon tank 5000 pounds of lime are dissolved. No difficulty has been experienced at Miami in feeding a solution as thick as this. The lime feed is proportional to the flow through the raw water venturi meter.

The lime dosage is at the rate of $11\frac{1}{2}$ grains per gallon or 1643 pounds per million gallons. Alum in the amount of $1\frac{1}{4}$ grains per gallon is added to facilitate clarification and for color removal. The alum is fed dry.

Chemical storage tanks, scales, slakers, solution tanks, proportional feeds and pumps are all in duplicate. As installed, equipment operates by fill and draw method. The equipment may be changed to continuous slaking and feeding operations and the capacity increased to over 50,000,000 gallons per day.

Mixing tanks

The mixing tanks are of steel on concrete foundations, approximately 30 feet in diameter by 22 feet in height. The water enters

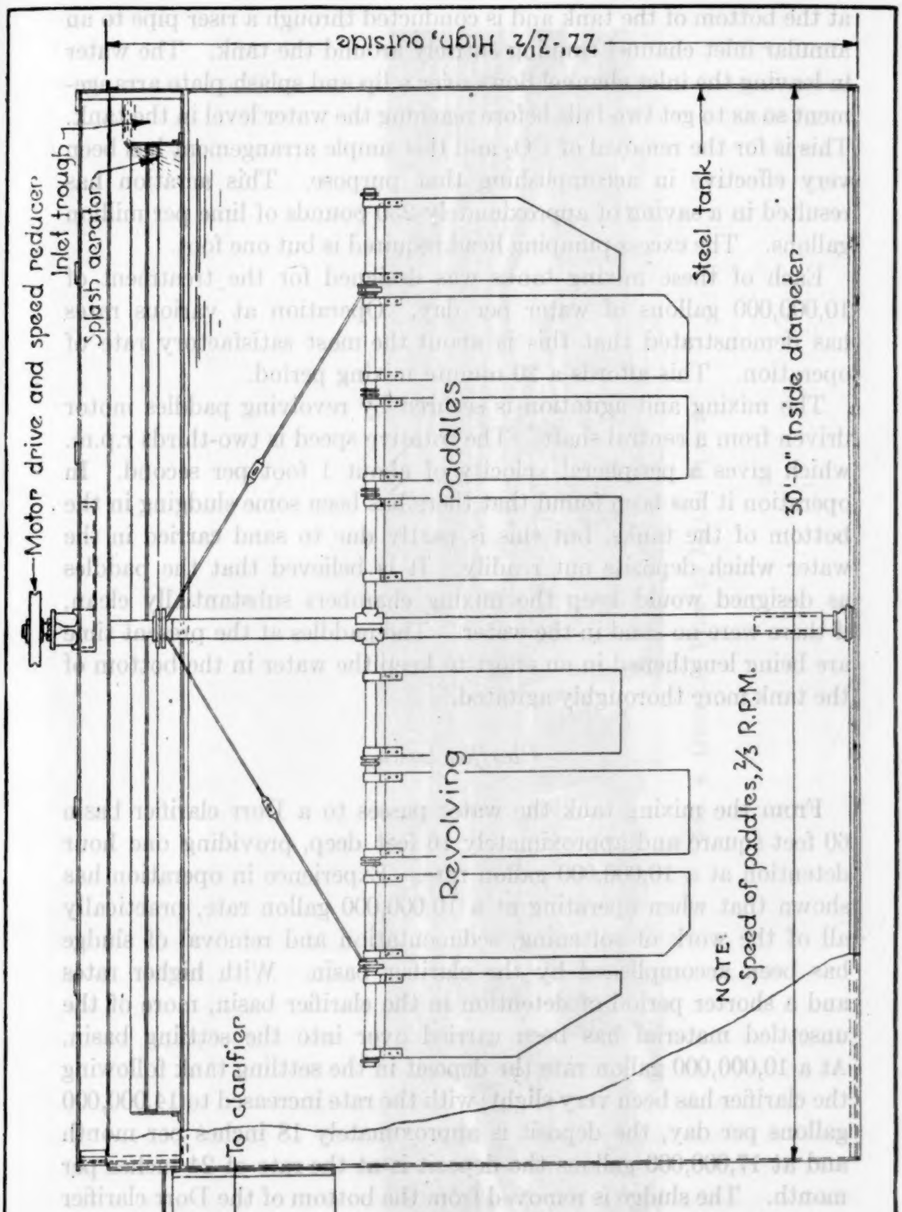

FIG. 3. SECTION THROUGH MIXING TANK

at the bottom of the tank and is conducted through a riser pipe to an annular inlet channel running entirely around the tank. The water in leaving the inlet channel flows over a lip and splash plate arrangement so as to get two falls before reaching the water level in the tank. This is for the removal of CO_2 and this simple arrangement has been very effective in accomplishing that purpose. This aeration has resulted in a saving of approximately 250 pounds of lime per million gallons. The excess pumping head required is but one foot.

Each of these mixing tanks was designed for the treatment of 10,000,000 gallons of water per day. Operation at various rates has demonstrated that this is about the most satisfactory rate of operation. This affords a 20 minute mixing period.

The mixing and agitation is secured by revolving paddles motor driven from a central shaft. The rotative speed is two-thirds r.p.m. which gives a peripheral velocity of about 1 foot per second. In operation it has been found that there has been some sludging in the bottom of the tanks, but this is partly due to sand carried in the water which deposits out readily. It is believed that the paddles as designed would keep the mixing chambers substantially clean, if there were no sand in the water. The paddles at the present time are being lengthened in an effort to keep the water in the bottom of the tank more thoroughly agitated.

Clarifier basin

From the mixing tank the water passes to a Dorr clarifier basin 60 feet square and approximately 16 feet deep, providing one hour detention at a 10,000,000 gallon rate. Experience in operation has shown that when operating at a 10,000,000 gallon rate, practically all of the work of softening, sedimentation and removal of sludge has been accomplished by the clarifier basin. With higher rates and a shorter period of detention in the clarifier basin, more of the unsettled material has been carried over into the settling basin. At a 10,000,000 gallon rate the deposit in the settling tank following the clarifier has been very slight; with the rate increased to 14,000,000 gallons per day, the deposit is approximately 18 inches per month and at 17,000,000 gallons the deposit is at the rate of 24 inches per month. The sludge is removed from the bottom of the Dorr clarifier basin by pumping with a Dorrco pump for a period of about an hour three times daily.

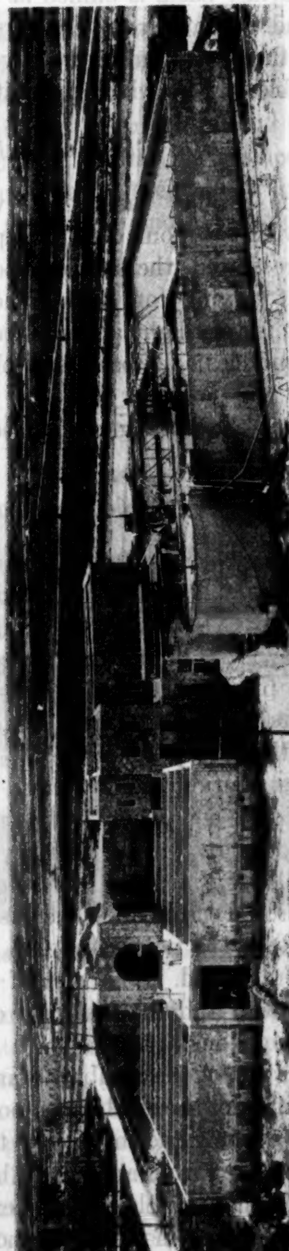

FIG. 4. GENERAL VIEW OF MIAMI PLANT

The Dorr clarifier basin is baffled at the inlet and the outlet and both inflow and outflow are over wiers. There is no visible short circuiting and the operation has been very satisfactory at all rates even up to double that for which the unit was designed.

Settling tank

Following the clarifier basin there was provided a rectangular settling tank with two hour detention period at a 10,000,000 gallon rate. As before stated, the sludge deposited in this basin has been small in amount varying from a few inches to a maximum of 24 inches per month. It is very light and can easily be removed. It is possible to drain and clean the basin and place it back in service in one day.

The water from the settling tank passes over a wier to the carbonating basin.

Carbonating basin

The carbonating basin is 60 feet square and approximately 16 feet deep. It provides a detention period of one hour for a 10,000,000 gallon rate. The CO_2 instead of being distributed through filtros plates or other type of false bottom, passes through a grillage of small galvanized iron pipes. These pipes are $\frac{3}{4}$ inches in diameter spaced at 2 foot centers drilled at 24 inch center with $\frac{1}{16}$ inch size orifices. Observation of the absorption of the CO_2 gas by the water shows that this type of distribution under a head of 16 feet is very efficient. The carbonization is complete with the period cut to thirty minutes. The CO_2 gas is developed by an ordinary oil burner somewhat similar to the household heating type. The gases are collected and run through a cooler and scrubber. The gas runs about 14 per cent CO_2 and approximately 155 pounds of CO_2 are being used per million gallons of water treated. The cost of the carbonating equipment was less than \$3000 and the fuel cost of operating is less than 30 cents per million gallons.

Early in operation of the scrubber some difficulty was experienced due to deterioration of the steel in the bottom of the scrubber. This was corrected by lining the interior of the scrubber with brick and subsequently changing from an asphalt base oil to a paraffin base oil since which no further trouble has been experienced.

Acid tests of the sand in the filters show that the carbonization is effective in preventing sand growth and after deposits.

Filters

From the carbonating basin the water passes directly to filters. The original installation consisted of 4 filters each of 2,500,000 daily capacity when operated at the ordinary water works rating of 2 gallons per square foot per minute. Four additional filters, bringing the capacity to 20,000,000 gallons per day, have since been installed. These filters have nothing unusual in their construction other than that they are of the central gullet type and have a deep gravel layer.

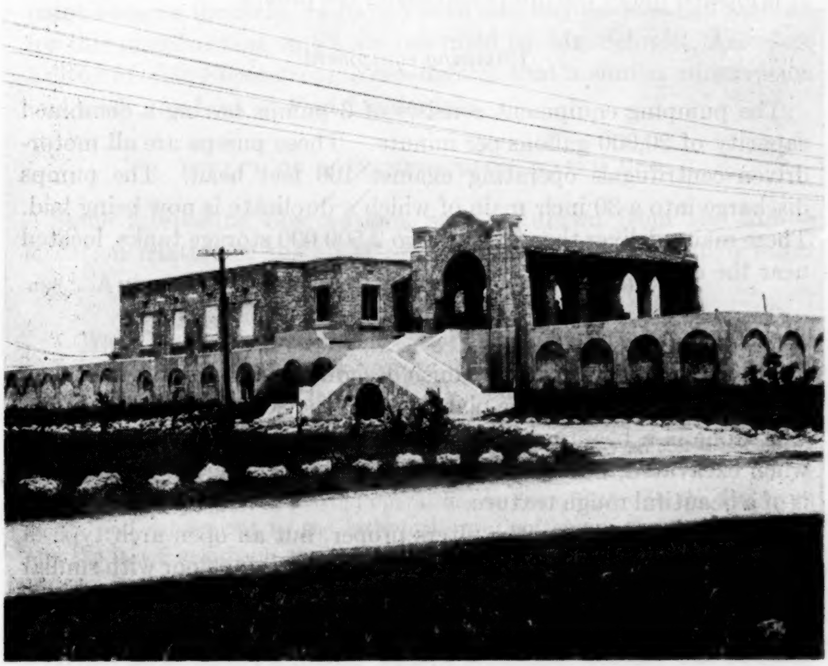

FIG. 5. SUPERSTRUCTURE OF SPANISH DESIGN

By the time the first 4 units were placed in operation, the average pumpage exceeded the rated capacity of the plant and before the next 4 units were completed, the plant was required to operate for as much as a month at a time at an average of 25 per cent above rating or at the rate of $2\frac{1}{2}$ gallons per square foot per minute, and for shorter periods at a much higher rate The filters demonstrated their ability to handle water at high rates without difficulty. It is believed that, in the softening of well waters, whose preliminary

treatment is as satisfactorily performed as at Miami, filters can operate continuously at a rate of $2\frac{1}{2}$ to 3 gallons per square foot per minute without any difficulty, and somewhat higher for short periods if all piping, controllers, etc. are designed with that in view.

Clear well

The clear well has a capacity of approximately 750,000 gallons. It serves substantially as a receiving well and pump section well. It is located under the filters and under the pumps.

Pumping equipment

The pumping equipment consists of 3 pumps having a combined capacity of 20,000 gallons per minute. These pumps are all motor-driven centrifugals operating against 100 feet head. The pumps discharge into a 30 inch main of which a duplicate is now being laid. These mains deliver the water to two 2,500,000 storage tanks, located near the city.

Super-structure

The super-structure is of Spanish design. It is built of stone taken from the excavation for the plant and for the 30 inch discharge main. The stone is a beautiful buff colored limestone which is rather soft when excavated, but becomes very hard on exposure. The surface is of a beautiful rough texture.

There is no roof over the filters proper, but an open arch type of construction with tile roof covers the filter operating floor with similar construction connecting the operating floor with the laboratory, office and pump room.

EFFECT OF HURRICANE

During the hurricane of August, 1926, when the wind reached a velocity in excess of 130 miles per hour, the plant structures were given a severe test and, with a few exceptions, came through in very good shape.

The windows of the pump room are horizontally pivoted with the tops swinging inward. During the storm the fastenings of these windows failed and the wind came into the pump room, lifted some of the concrete roof tiles and carried several slabs as far as the clarifier

basin, some 40 or 50 feet away. These slabs caught the mechanism of the clarifier and stopped its operations.

The roof over the operating floor was anchored by bolts into the stone work. Cracks along the arches show that the wind must have lifted this roof vertically and set it down again in its original location.

It was observed after the storm had passed that the diagonal rods on the wash water tank were sagging. The tank had been painted just prior to the storm. Inspection showed that the turn buckles had apparently unscrewed about three threads as evidenced by the paint lines on the rods. I have yet to find anyone who can account for this phenomenon, but I am informed by Mr. Schmitt, Associate Editor of the *Engineering News-Record*, that a similar observation was made of a tank at Fort Lauderdale.

EFFECT OF SOFTENING UPON WATER USE

Some interesting observations may be drawn from the Miami situation relative to the effect of a better water supply upon water use. A study of the Miami figures shows the following:

1. While the average increase in water pumpage for the four years prior to softening was 14 per cent per year, in the two years after softening the increase was 71 per cent per year.
2. While the average use per consumer for the four years prior to softening was 518 gallons per day, it has averaged 975 gallons per day since the softening plant started operations.
3. The softening plant started operations in June, 1925. In the five years before and subsequent to the introduction of softening, the first 6 months and the last 6 months of the year at Miami show substantially equal uses of water. In 1925 when soft water was available in the last half of the year only, consumption in the last 6 months was 158 per cent of the first 6 months.

While these rather startling figures were undoubtedly due to some extent to the fact that the introduction of soft water occurred simultaneously with the greatest real estate boom at Miami, a study of the figures shows that without a doubt the water supply contributed a large part if not the major part of this growth.

COST

The total cost of the softening plant was $486,961, of which approximately two-thirds was for basin and building construction and one-third for filter and chemical equipment and piping.

With the construction of the second clarifier basin, which will be 110 feet square and for which plans have been prepared, the plant will have a capacity of 30,000,000 gallons per day.

The water supply was investigated and developed by Mr. Ernest Cotton, Director of Public Service, of Miami, Mr. Jas. H. Cox, Engineer of Water Division, organized and executed the construction of the plant. The filter equipment was furnished and installed by the Roberts Filter Company. The lime feeding equipment was furnished by the International Filter Company.

Alvord, Burdick & Howson of Chicago were the engineers, assisted by Mr. Charles P. Hoover on the chemical features and Mr. Victor A. Matteson on the architectural design.

SUPERINTENDENTS' QUESTION BOX SERIES[1]

BOOKS OR CARDS FOR CONSUMERS LEDGERS AND GENERAL PRACTICE IN BILLING

CHAIRMAN W. S. PATTON: Of 83 replies received to a questionnaire regarding the choice of books or cards for consumers ledgers 33 prefer books, 47 prefer cards or looseleaf and 3 prefer both.

J. E. GIBSON (Charleston, S. C.): When I first went to Charleston in 1917, we had bound books for about 5500 consumers. The Department had tried to carry those 5500 accounts in about 6 books; they were great heavy books. We used young ladies for clerks and about all they could do was to carry one of those books. People would come in and want to pay an account that was recorded probably in the sixth book. The clerk had to lift anywhere from the one to five other books to get to it, because whoever used the books last would not put them back on the shelves at the time in uniform order.

I consulted with the Library Bureau people at that time and we decided that we would change to a card ledger system, in which each account was on a card 5 by 8 inches. It carried the information as to the location, the customer, the size of the tap, the size of the main, the size of the meter, the meter number, and when the meter was set, but the principal point on the card after the location of the account or premises, was the column for billing. When we indexed that card it was according to the street number and name; then we made up a corresponding card for the meter reader. We bought a file cabinet that would hold the cards, and it was on rollers, so that in the morning when the office was opened, the first thing the porter did was to roll these account cabinets out in the room where the girls were working. When a consumer came in and wanted to know something about his account, all the girl had to do was simply to pull the drawer open and thumb right to the number of the account. A card index system of accounts carried the number of the account in the ledger file. We found it very satisfactory after some three or

[1] Presented before the Chicago Convention, June 6, 1927.

four months use, when I took a vote of the girls in the department to learn how they felt about the card system versus the old book system. Although at first they had opposed it because they thought there would be some difficulty in using cards and in balancing them at the end of the month.

At first we balanced our accounts once a month, but we are now carrying a control card in each cabinet, so that at the end of each afternoon we close the office to the public at four o'clock and the girls leave at five. At five o'clock they tell me exactly how much money they have collected that day and how many dollars of unpaid bills are outstanding. In other words, we have at the end of each day, a complete balance. We know which water bills have been billed, what money has been paid and what still remains unpaid. In ten years of operation I think we have lost two cards. In one case a young lady was talking to a new minister who came to town. She got out the old account for some reason and he picked it up and slipped it in his pocket and walked off with it. That is the only account we lost. We reproduced that by simply going back to our meter records which carried the meter readings on the card and reproduced the card in its entirety. What became of the other card we have never yet been able to find out. I am inclined to think that it has been placed in the canceled or voided cards that have been filled up and we have not run across it. We have, however, reproduced the card. We never lost any money and we have never had any cases to go into court. I believe that is the one bugaboo about cards or loose leaf ledgers, that the courts do not put much faith in them because a card can be replaced. In a bound book the page cannot be replaced, but I do not see that that need prevent anyone from using the looseleaf or the card system. We prefer the card system. The cards are, as I said, about 5 by 8 and I have them made on rather stiff bond or Bristol board. They stand a surprising amount of wear. They are filed vertically and in billing they are taken out of the box and handled right on the billing machine leaf of the table, so that there is no heavy volume to be handled, or leaves to be thumbed. All of us have been won over to the card system. We certainly would not consider going back to the books.

A MEMBER: Might I ask Mr. Gibson how many hands he employs in the office besides himself.

J. E. GIBSON: In handling the cards there is one lady who makes the bills and a second who posts them. There is a third who has to handle these cards each day because we use a continuous system of reading and billing. The third lady goes back ten days and takes the accounts, bills that are ten days old and makes from those a delinquent notice which she mails at night, so that for handling approximately 10,000 accounts, we have three young ladies. Of course, there are other young ladies receiving cash and attending to the other routine work of signing up new customers and making changes on the books, etc. In the main office we have six in total, one of whom acts as my stenographer and does the general stenographic work for the rest of the office, and our treasurer, who has the general account of the commission; but the three young ladies really handle the consumers' ledger accounts entirely.

CHAIRMAN PATTON: Are there any other questions? I notice in the questionnaire that 33 answered that they preferred books against 47 who preferred cards or loose leaf. I would like to ask everyone who is using books to hold up their right hand. There are fifteen using books. How many are using cards? Thirty. It looks as though we were working into cards.

G. G. WALDROP (Fort Wayne, Ind.): I held up my hand as using a card system. Our system is equivalent to the card system. We use in the billing machine what we call a triplicate stub, as the office stub that is cut off of the bill, after the billing is completed. There is the cashier's stub which is on the paying portion of the bill. When this bill is paid at the cashier's window, she stamps it "paid" and holds it for her records. At the end of the day this stub is compared with the office stub and both are stamped and put in the permanent file. When I took over the office on January 1, 1926, the ledgers were weighing, as our friend stated a moment ago, about 75 pounds each. We found that our ladies could not handle them. We had to replace these ledgers at a cost of $12.00 or $13.00. That is what got me to digging into the proposition and we adopted the short cut method which is proving very satisfactory since the first of this year. I think it is the only system, much more economical and quicker than the others. The unpaid accounts are before you at all times; there is no necessity to leaf through the ledgers, you do not have

to pull them down, and in the course of 90 days we will have our ledgers entirely eliminated and be using the stub system entirely.

S. B. Morris (Pasadena, Cal.): We also use a stub system and have not used the card ledgers or the book ledgers.

R. M. Roper (East Orange, N. J.): I just want to endorse what the last two speakers have said. We in East Orange have about 10,000 accounts. We originally started with the old book system, then some four or five years ago went into the card system. The latter is much more handy for office records than the book system, but both of them had their drawbacks. We investigated all the systems around the metropolitan area of New York and finally adopted one which is used now on a system controlling about a million meters. This system corresponds with that mentioned by the last two speakers, eliminating everything but a reading book, in which we have loose leaves for the original entry of the reading of the meter. From there goes directly to the billing machine. One copy of the bill is our permanent record for the files and it goes into an unpaid file. When the account is paid that is transferred to the paid file and just as Mr. Gibson, with his card system, has a check at the end of each day we have a tabulation sheet which follows in the machine and gives a summary of the total, previous reading, present reading, consumption and financial equivalent, which can give us a balance at the end of every day. We find it is far in advance of either the old book or the card system.

C. M. Crowley (St. Paul, Minn.): We handle about 55,000 meter accounts and during the last four years we have been using cards. Previous to that time we had the loose leaf bound ledgers. We show on the meter reader's book what that meter supplies and the same on the ledger. We find that, where meters stop and we have to pro-rate on accounts, that information is valuable, especially with new accounts, and will give us some data to pro-rate. We charge the ledger clerk with the responsibility of charging that account. He is to determine whether it is to be billed as the meter reader returns it, or held out for a re-reading, or whatever purpose it may be. If he puts it on the ledger, the same reading book goes back to the bill clerk who bills and carries the schedule of the reading, the old and new reading, consumption, water charge, service charge, and

total charge, which is checked by the machine. Then the tally rolls of the ledger clerk and billing clerk are compared which puts the ledgers in balance every night. We find it very economical to divide the city into three districts for the smaller meters, one inch and less. We read one district each month and, much like Mr. Gibson, we keep a continuous process of charging and billing and are able to handle it with one cash window. We have been able to take off our trial balances, generally in about two days and the stubs are always preserved for two years. We keep a control ledger so that when the clerks come to their trial balance at the first of the month they must tie up with the control clerk; then there is no doubt as to the accuracy of our accounts.

Mr. Powell (Griffin, Ga.): Until three years ago we used a loose leaf ledger which was unsatisfactory. We have adopted a card system. We use a billing machine in making our bills and the record on the ledger sheets is made at the same time. We have lighting bills to make, but the same bill carries a customer's lighting, power and water accounts, although the water department and the lighting department are separated. We carry about 2000 water customers and about 2700 lighting and power customers. We only require two girls and, except from the 18th to the 10th, they have pretty much of a loafing job.

Chairman Patton: The next question is, "If books are used, which kind have you found most convenient, books with a page for each consumer, or books with a number of consumers to the page." We received 82 replies; 66 found that one consumer to the page was most convenient; 16 that two or more consumers to a page was most convenient.

Chairman Patton: To the first question 74 replies were received; 58 answered yes and 16 answered no. Do you arrange your meter sheets or your cards the same as the meters? Most of those present seem to prefer to arrange them with the meters. Now the question is, "Do you depend upon an alphabetical index for your ledgers?" We received 79 replies to that question; 31 answered yes; 46 answered no; 2 answered yes and no. It seems to me that an alphabetical index for the ledger is a very nice thing. Where the meter sheets are arranged the same as the writing of the meters, if you have the

house number you can locate your consumer, but it seems to me that an index is a very valuable thing. I will ask Mr. Christy how his are arranged or indexed?

J. F. CHRISTY (Jonesboro, Ark.): They are indexed.

CHAIRMAN PATTON: Do you use an index?

MR. CHRISTY: We do in the water department. We have the water, light and sewerage. Everything is in numerical order in the water and also the electrical department.

CONTINUOUS BILLING

CHAIRMAN PATTON: The next question is, "Have you tried continuous billing? Do you prefer it?" 78 replies were received; 35 answered yes; 32 prefer it; 2 were non committal; one does not prefer it. 43 answered no; 40 do not prefer it, 2 were non committal; 1 would prefer it. Continuous billing seems to be the modern trend. Personally I have been opposed to it, but I suppose I shall come to it.

MR. WALDROP: It is the only thing you can do where you have a large number of customers. We have 36,000 in Fort Wayne.

MR. PIERCE (Springdale, Pa): We have a ledger system and a separate sheet for each meter, which are arranged according to the house numbers and street. In Pennsylvania, where this plant is located, the delinquent water bill becomes a lien on the property and we are not interested in the individual. Each sheet corresponds to a similar number in the ledger. When we have to look up a bill we refer to the number. They are all arranged in numerical order.

C. M. CROWLEY: That is the practice in St. Paul. We use a code system, the numbers are consecutive. We split the streets and leave part of that street in one district one month and the rest another month. Our charges are a lien against the property and we do not feel concerned about the arrangement between the landlord and the tenant. They have to settle it themselves.

J. W. CROW (Ponca City, Okla.): In arranging your ledger alphabetically, I do not see how you would have to change your ledger sheets every month, if the tenant moves. If he did move, I would carry mine with the address of the street. If he moved, use the same sheet for the next man who moved in and change his name. It is not alphabetical for the name, but for the location of his meter, the number and name of the street, regardless of who lives there. One tenant moves out and another moves in, you still have his address.

If you carry it alphabetically, you have to change your sheet around every time.

Chairman Patton: I do not believe that there are many plants that could handle it alphabetically. The street number remains the same, but an index arranged alphabetically is a very great convenience.

Are the bills collected by the Treasury Department of the City or by the Water Department?

Chairman Patton: To that we received 83 replies. In 12 cities bills are collected by the Treasury Department; in 47 cities bills are collected by the Water Department; 24 cities are supplied by private water companies.

W. W. Brush (New York, N. Y.): I should like to ask whether anybody here represents a city where the system had been to have the Water Department collect the bills and where that system had been changed to have the City Treasurer, or whatever may be the designation of the financial department, collect the bills. What has been the experience? I ask that because in New York it has been advocated by a good many people at this time that the collection, which is now through the Water Department for current bills, be turned over to our controller or financial officer. Our arrears go to the controller for collection, but our current bills are collected by the Water Department. It would be interesting if anybody has had the experience of shifting from one system to the other, if they would tell us what has been that experience and what is his view of the desirability of such a change.

R. M. Roper: I think I can get at it by reversing Mr. Brush's question. In East Orange all water accounts were collected originally by the City Treasurer's office, even though the Water Department office and the City Treasurer's office were in the same building. We found that there was a great deal of inconvenience caused to the consumers. They would go to the Treasurer's office to pay the bill and some little question would occur to them to ask the Treasurer. He would say immediately, "I will have to refer you to the Water Department," which necessitated a trip to the Water Department

to get the information or some little change in the bill. It would take the consumer's time to go to three places where he should have gone to one. It also piled up the work of the City Treasurer's office, where there was a big line to be handled. About four years ago we changed the system entirely and the water revenues are all collected at the Water Department and turned over and receipted for each day to the City Treasurer. We have had a great many compliments from consumers on the change, because of the convenience to them.

W. W. Brush: Does that change add to the cost for the city, would you think?

R. M. Roper: It takes the equivalent of about half the time of one person as cashier. It does not add to the cost to the city, because it transfers that charge from the City Treasurer's office to the Water Department office, but it is more than made up for in the convenience to the consumers and in eliminating congestion in the Treasurer's office at the time of paying bills.

Phil Carlin (Sioux City, Ia.): At Sioux City until about twenty years ago, the Water Department collected all the bills. About ten years ago the Water Department concluded they'd better have the City Treasurer collect this money. The Water Department sent the bills out, but the Treasurer is on the same floor and close to where our working force is. He collects the money and he can hear all that is being said in regard to any dispute about the bills, etc. We can overhear it and we find that arrangement very handy. We contribute $100.00 a month toward the salary of the City Treasury. It would cost us from $1800 to $2200 a year to collect this money.

Wm. R. Young (Minneapolis, Minn.): For many years the Water Department collected its own bills. It seemed to be a very satisfactory arrangement at that time, but the city made it necessary for all money to be collected by the City Treasurer, and then our collections went through the Treasurer's office. There are approximately 100,000 accounts. The work has been very satisfactory between the Treasurer's collection and our collection. Every afternoon at four o'clock the Treasurer's Department sends to our office all the coupons and a summary of the collection of the day

which runs into many thousands upon certain days. The only objection we can find to this method is that which the gentleman from East Orange pointed out. The Treasurer's office is on the first floor and we are on the second, in a large office building. Many people come in to pay their bills in the office of the Water Department and are referred to the Treasurer's Department. By the time they have gone up to the next floor to pay their bills, they will happen to think that the name may be wrong or the bill may be too large and will be referred back to the Water Department.

THOS. J. SKINKER (St. Louis, Mo.): In St. Louis about ten years ago the Water Department collected their bills. The collector now collects them and we have similar trouble to the East Orange company. We have the same complaint about bills which have to be referred back. It is not a very satisfactory arrangement. There is some talk now of changing to the old system, if possible, and letting the Water Department do its own collecting.

MR. PIERCE (Springdale, Pa.): The Treasurer collects the water rents and it seems to work satisfactorily. It eliminates a certain amount of kicks. When consumers came to the water office to pay their bills, they used to think up, or at least we presume they thought up, a complaint about their bills, especially in the summer time when they watered their lawns. By going to the treasurer and paying him, they do not take the trouble to come over and kick to us. Secondly, it saves us a number of duplicate bills. If they forget their bills once and have to walk over to our office, it does not make them feel so very good and they are not so apt to lose the bill the next time it comes. Third, the check which the auditors will be able to obtain is much more satisfactory. We make the bills and charge the treasurer with that amount. He collects them and turns over to us the stubs and the duplicate receipts for the money deposited in the bank, the auditors check our bills against the treasurer and also the canceled checks.

J. F. CHRISTY (Jonesboro, Ark.): We have the best system of all. We collect the money and keep it; we turn nothing over. Jonesboro is a city of about 17,000 population. We are operating under a special act with a commission. We collect all the money and we spend all the money, every bit of it goes right back into the system,

either sewerage, water or lighting system. There is no connection at all with the City of Jonesboro and the water and lighting department. The men are being selected on the basis of property valuation, that is, the property owner gets a vote for every dollar of state and county tax paid, which removes it largely from the political issues which might arise.

We have just completed a new $200,000 power plant. We call on the citizens for no money, issue no bonds against the property whatever. We made a bond issue of $200,000, but only against the power plant. We make all extensions of the water mains with no assessments against the property. We are completing a $30,000 septic tank and spending $15,000 in sewer extensions and there is no charge against the property owner for any extensions or improvements. It is all paid out of the earnings. Everything is handled by the commission elected for this purpose. The sewers are kept up through the earnings of the water and light departments. We have the lowest rate in the state of Arkansas.

ARE BILLS MAILED OR DELIVERED IN PERSON?

CHAIRMAN PATTON: "Are bills mailed or delivered in person, and why?" 77 replies were received. In 50 cities bills are mailed; in 19 cities bills are delivered in person. In 8 cities some are delivered by mail and some in person. Of the cities mailing bills, 19 said it was cheaper to mail them than to deliver them in person; 7 said it was more convenient; 13 that it gave better results and 11 did not give any reason at all for mailing them. Of the 19 cities, where the bills are delivered in person, 11 thought it cheaper to deliver the bills in person; 3 thought it more convenient; 3 thought it gave better results and 3 gave no reason.

P. J. HURTGEN (Kenosha, Wis.): We deliver practically all our bills in person. We hold the property owner for the water bill and not the individual and unless the property owner asks to have the bill mailed to him we deliver it in person, for we do not know who is going to pay the bill. Many properties are bought on land contract, and our contract is with the owner and not with the person who holds the land contract. Yet the person who holds the land contract is the person who pays the bill. That is the main reason why we deliver the bills in person, because by doing so we reach the man who actually pays the bill. While on our books we have the name of the owner of the property, he may not be the person who pays the bill.

CHAIRMAN PATTON: I think that is a very important question. I have always thought it was better to mail bills, because a great many people who pay their bills are business and professional men. If you mail the bill it goes directly to his office.

W. W. BRUSH (New York, N. Y.): That is outside of my bureau. My recollection is that in New York we have to send for our bills. That does not refer to meter bills which are mailed, but we have to send for our frontage bills. If we send the postage, they will be sent by the city. The water rents are a lien on the property. Therefore, the question of whether the bills are paid promptly or not is not such

a serious matter in financial returns to the city. It seems to me that, with us, probably mailing would be the better plan, but I am guessing at that because it is something with which I do not personally come in contact.

GEO. G. WALDROP (Fort Wayne, Ind.): We deliver the water bills by hand for 36,000 customers. We absorb this by our meter readers through their idle periods without any additional cost. We consider it more economical.

J. F. WILLETT (Billings, Mont.): Years ago we used to deliver all our bills with the exception of people receiving two or more bills and they were mailed. We mail all bills now. We find it eliminates a great many complaints where people say they did not receive their bills. The post office department objected to placing bills in the mail boxes. Therefore, when people were not at home, we had to put the bills under the door, or under the screen door, in a place where they might be safe, but the wind would blow them away and a great many people complained that they never received bills. We have greater satisfaction in mailing the bills.

DOES PROPERTY OWNER OR THE TENANT PAY THE WATER BILL?

CHAIRMAN PATTON: In how many cities is the property owner responsible for the bill. We have 30 in municipally owned plants. In how many municipally owned plants are the tenants responsible for the bill? In municipally owned plants apparently 15.

J. F. CHRISTY: I do not believe this question is clear in the minds of these gentlemen. Is it not a fact that, in the payment of these water bills, those of you who held up your hands are mostly metered cities. Do I understand now that the property owners pay these water bills where they are metered or do they require the tenant to pay the water bill? In the period when we used to have so many flat rates, the property owner usually paid the bill, which was a flat rate bill, so much per quarter in advance. The bill was the same every year, depending on what fixtures were in the house. As they began to put in meters, the property owners got away from that. They do not want to stand for the meter bill. They have deducted possibly a dollar or two from the rent and they say, "Now the tenant must pay the water bill." This is good practice.

CHAIRMAN PATTON: How many of the plants here voting are metered?

A MEMBER: Do you mean universally metered?

CHAIRMAN PATTON: Not necessarily, metered or being metered.

J. F. CHRISTY: Seventy-five per cent metered. Do the property owners pay any of the bills that are metered? I would like to ask the next question, how do you find those that pay the meter bills?

STEPHEN H. TAYLOR (New Bedford, Mass): I might say that in New Bedford we only recognize the property owner. We are all metered. Some of our large tenement houses have only one meter

and the owner pays that bill. If he cares to sub-divide it between his tenants, he can do so by private meters, but, as far as the city is concerned, we look only to the owner for the water that goes into his property. We send our bill to the owner. If he passes it on to his tenant and he pays it, that is all right, but the owner of the property is the man we hold responsible for the charge for water in that property.

WM. R. YOUNG: In Minneapolis we hold the property owner responsible for all the water bills, although, if we have no mailing address to which to send the bill, it is mailed to the owner or occupant. Our real estate leases in Minnesota provide, in the majority of cases, that the tenant pay their own water bills. While the property owner is held responsible, it is a matter of mutual agreement between the tenant and the owner as to which one pays it. It is immaterial to us and we do not know who pays it.

MR. HURTGEN: In answer to this question, the state law of Wisconsin provides that any unpaid water bills that are not paid the first of November, are a charge against the property, so that any legislation on this matter must be based on the state law. The state law of Wisconsin provides that any charge whatever, either water bills or repairs on meters are a tax against the property. If those bills are unpaid the first of November, they are to be entered on the tax roll against the property. Our contracts are with the property owner. We have a signed contract with every consumer, that is signed by the owner of the property. The owner of the property owns the meter and is charged with the water bill, if it is not paid by the tenant or the holder of the land contract. That is a state law.

MR. MCDOWELL: I think that is an answer to this question as to whether the bills are mailed or delivered in person. We state that the custom in Charleston is to mail them. We find that that is the more satisfactory method. The contract for water is made with the tenant in Charleston. There is no law in South Carolina that holds the water bill to be a lien against the property.

MR. CARLIN: We have 16,000 consumers in Sioux City, and we are 100 per cent metered. We hold the property owner responsible under our ordinances. I am going to ask a foolish question, while I am on

my feet. How many present allow the turn-off and turn-on men to collect the bad bills, if any?

CHAIRMAN PATTON: Let me see if I understand your question; you want to know how many permit the turn-off and turn-on men to collect the bills. Do you mean not send any cards at all?

MR. CARLIN: No, no; a bad bill. When they have orders to go out and shut off a certain consumer and that consumer is willing to pay that amount, do they allow these men to collect?

CHAIRMAN PATTON: You mean delinquent bills?

MR. CARLIN: Regular bills to consumers who have had notices to pay and have not.

CHAIRMAN PATTON: I would be glad to hear from some one.

PATRICK GEAR (Holyoke, Mass.): In Massachusetts, we have a state law for a lien on the property, but you do not have to accept it, if you do not want it. The water department can accept it or not. We accepted it, but we did not want it very badly because our Water Commissioner's "yes" or "no" in two minutes is law with them. They could shut off or turn on the water if they were so inclined. They could cut off the water in two minutes, advertise your property and sell it, but, answering Mr. Carlin's question, if we have a bad bill we send a man out to shut it off and if a woman gives him a check and the check is no good, he does not take any other check. There is a law in Massachusetts that, if you issue a bad check you go to jail, so there is no chance of a bad check. We allow them therefore to collect the bill.

PHIL CARLIN: In a city the size of ours we found in the last two years that a great many double houses, which formerly supplied two families, are being changed into flats, kitchenettes, etc. A great many of the larger houses are changed into duplexes. It is not practical for two meters and we insist on only one meter. We had it out with the real estate board some years ago. They were quite intent upon making the tenant responsible and letting the water department carry on a profit and loss system for their tenants. After

discussing it for some time I wrote thirteen points for them showing why it was impractical. The landlords said the most expensive water they had would be the hot water. One tenant would use it one day and another another day. In the sprinkling season of the year, the sprinkling was done from one service and they could not separate it. There was so many objections to it, that they decided they would have to make it a matter between the landlord and the tenant. Our law makes it a lien against the property. It has been very rigidly enforced. For example, the Department of Education has some blocks where there were tenant houses. We knew nothing of it for some time and they allowed the tenants to remain. The tenants lately vacated the premises and we sent the bills to the Department of Education. They tried to repudiate them, but the City Attorney said they were obliged to pay them for they were a lien against the property.

Mr. Joplin (Princeton): I represent a small, privately owned company. We meter every customer. We also send out delinquent bills with our shut-off man. If he can make the collection well and good. If he does not make the collection, he does not take any promises. It must be the money.

Wm. G. Banks (Newark, N. J.): In Wildwood, N. J., the owner must sign a contract and it is a lien against the property. We serve two other municipalities and the owner must sign for the water where it is not a lien against the property. We issue our bills the first of the year for the minimum charges. If they are not paid, we do not bother with them, but, in the other municipalities, we give them sixty days and at the expiration of that time if they do not pay, we give them a ten day's notice. It must be paid within that time or it is shut off without further notice. We make up an account in the form of districts. The man who makes the turn-off has the amount of the bill plus 1 per cent penalty a month. He must get the money at that time or shut off the water. In Wildwood, proper, where they owe a bill, where it is a lien against the property, we do not bother.

Mr. McEvoy (Dubuque, Ia.): We have 8500 consumers. We do not hold the property owner responsible, except for properties where there are two meters. The tenant pays the water bill in most cases. The owner may, if he wishes to. We have no contact with

the tenant. We require a deposit of $3.00 from each tenant, which is, of course, refunded if they move to some house where they do not use city water. We find that that works very nicely. We read our meters daily and bill daily, that is, we make bills delinquent fifteen days after the bills have been sent out. They receive then a second notice giving them ten days further extension. If the bills are not paid within that time, a shut-off ticket is made out and the water is turned off. They have the right or the privilege to pay the turn-off man with a dollar penalty, before the water is turned on.

J. W. McAmis (Greenville, Tenn.): In reference to whether we deliver bills or mail them, we have a system that is not just like anything I have heard described here. About four years ago, we conducted a little survey in order to find out whether people really wanted a bill or not. We found about 50 per cent did not care whether they had a bill or not, they came to the office anyway. So we do not mail any bills unless a man who wants a bill leaves a request at the office. About 10 per cent of our consumers have a bill mailed out every month and it works out fine. A good many do not want a bill at all, but we do not allow our cut-off man to take any money, unless somebody is sick or in case of death.

Chairman Patton: Do you have meters?

Mr. McAmis: Yes sir. The property owner is responsible for the water bill if he owns the property and lives in it himself. Otherwise we collect a deposit.

Chairman Patton: Mr. McAmis's plan is like ours. We have a $3.00 deposit from the tenant and collect from the tenant. Our loss runs about 1 per cent. I have often wondered if it is not fair to collect from the tenant and make him responsible for the water rather than to hold the landlord. I should like to find out how many municipally owned plants require the money to be paid by the landlord? In other words, how many make the landlord responsible for the bill. Will you please hold up your hand so I can count? Twenty-eight. How many municipally owned plants make the tenant pay the water bill?

A Member: Require or permit?

CHAIRMAN PATTON: Permit or require. Of course, no one is going to object to the landlord paying the bill. How many will permit the tenant to pay the bill in municipally owned plants only?

A MEMBER: That question works both ways. Although the bill may be held against the property, the tenant may be permitted to pay it.

CHAIRMAN PATTON: All right, let us change that. Hold up your right hand, if the tenant pays the water bill and the landlord is not held and the bill is not a lien against the property. Twenty. It is pretty evenly divided.

MR. PIERCE: In Pennsylvania the municipally owned plant has a right within three years after the bill comes due, to declare a lien upon the property for it. I do not know of a case where it has been done, for two reasons; in the first place, we can shut off the water and the landlord will pay to get the water turned on. The second reason is that the constable's fee is rather heavy. Here is always a question of whether you are justified in spending five or six dollars to collect a water bill of an equal amount. The tenants can pay the water bill if they want to. We send all our water bills by mail on a government postcard that costs us about a cent and a quarter for the card and the postage. On the face of it, it is addressed to the tenant or owner, and on the back it, is marked for the owner or the tenant. Either may pay it. In the last analysis it is the owner who has to pay the bill.

C. M. CROWLEY: In St. Paul we have properties standing in the name of an owner whose ownership ceased several years ago. New owners are paying the bill and we do not find more than a quarter of them that will take the trouble to come in and change the name on the records to indicate that they are the present owners. That is the advantage we have in saying that we are dealing with that property. We are interested in this property and want it to pay this bill. We cannot go into research concerning the responsibility of the present tenant, the former tenant or landlord or anything of that kind.

S. B. Morris: You mentioned the fact that you were losers to the extent of one-half of one per cent and you require a $3.00 deposit. We lose about one-quarter of one per cent and require no deposit, except from one or two nationalities from whom we have learned to require deposits.

Chairman Patton: Is the landlord held responsible?

S. B. Morris: No.

Mr. Powell (Griffin, Ga.): We require on ordinary house services, a deposit of $3.00. Anybody can sign a contract who will put up $3.00. If they do not want to put up a cash deposit, they can get the property owner to sign for it. If a man owns his own house, he can sign without putting up a deposit. In every case, however, where the bill is not paid and we have a $3.00 deposit, and the tenant skips out, owing $5.00, say, we hold the landlord for the $2.00 before he can get the water turned on.

Wm. R. Young: In Minneapolis, in 27 years we never lost a dollar on a delinquent water bill, and the first of January, this year, on our delinquent list, we had about $3200. Every one of those bills are against property which is either vacant or the building is wrecked. Before the water can be used on that property again, those bills with penalty will be paid.

HOW ARE METER DEPOSITS HANDLED?

Mr. McEvoy (Dubuque, Ia.): We have a card index system of all consumers. When a tenant comes in and makes a deposit, we simply give him a card as a receipt. Then there is a card made out for him. When he comes in to discontinue the use of water, leave the city or move elsewhere, he brings in his receipt. The card is withdrawn, marked paid, and is put into another file.

Chairman Patton: You do not require the consumer to bring back the original receipt card?

Mr. McEvoy: We do. We tell them that, but it does not make any difference, because we have the record on the deposit card, with that withdrawn, there is nothing against the account. We pay no interest on deposits.

Mr. McDowell (Charleston, S. C.): The tenant pays the water bill in Charleston. The contract is made with him. He is required to make a minimum deposit of $5.00 up to $25.00, depending on the quantity of water formerly used on those premises. We pay 6 per cent interest on the amount of money, if it is allowed to remain with us for a period of over three months. He is given a receipt, which is consecutively numbered in a printed book, and a carbon copy is made of that receipt. When he cancels his contract, he brings back his receipt and he is paid. If he does not have the receipt, a check is mailed to him and we have the check as evidence that he has received the money.

Mr. McEvoy: I wish to correct myself on that card. When he comes in, if he does not have the receipt, or even though he does have the receipt, he signs this card as a receipt which we retain in our files. It is simply withdrawn and put in another file.

Mr. McAmis: We issue a receipt for deposits. We have a vacant place on the ordinary bill, marked "miscellaneous." We put the

amount of the deposit on there and issue a receipt for it. When a man comes back and wants his deposit, we issue a check payable to the person whose name appears on the back as having that deposit with us. In that way we get away from any dispute about who shall collect the deposit; we make it out to the man who gave it to us. If he is dead, his heirs have to put the proper endorsement on the check before they can get the money.

MR. BOWMAN (Iowa): It is optional for the tenant to make a deposit for a three month's bill or, if the owner prefers to assume the responsibility, he may. The deposit is entered on the regular ledger card and we have billing cards which are mailed to each customer with a stub or cut-off coupon on it, with the name on the end. The amount of the deposit is entered on the billing card, showing that this is a deposit for a certain service at a certain street and lot number, for the bearer or tenant signing for it, showing a deposit only for that service. The coupon is clipped off, with the same amount on and entered on what we call our regular receiving ledger. In three years we have not had one case of shut-off and no loss, but the amount of the deposit is based not on the dollars and cents for each service, but on a three months billing. For a large customer we require a large deposit, on a domestic consumer, only a small one.

CHAIRMAN PATTON: What is required if the consumer is dead?

MR. BOWMAN: Well, I guess if the consumer is dead someone can come in and sign "John Jones Estate, by So and So."

CHAIRMAN PATTON: Is any different practice observed in that respect? Do you require an affidavit of any kind if the consumer is dead? I suppose everyone handles it the way we do?

DOES THE CONSUMER SIGN A CONTRACT BEFORE TURNING ON WATER?

W. S. Cramer (Lexington, Ky.): If you require a cash deposit, you have still something in writing.

Chairman Patton: That is all we have with a cash deposit I do not see any need of any contract, but I should like to hear from Mr. Cramer on that question.

W. S. Cramer: We require a deposit only in cash when the landlord refuses to sign. We have a contract that any consumer has to sign before he gets the service. It is optional with the landlord whether he signs or not. The tenant also has the privilege of having any person, who is a water taker, sign that contract. In our city we have in a total population of 50,000, some 14,000 negroes. It is rather a hardship on those people to put up the \$5.00 deposit we require where a cash deposit is made. In lieu of that we have a contract signed by both the tenant and the landlord, or by any property owner who is a water taker. The delinquent bill, if any, is added to the bill of the landlord or the guarantor, whoever he may be, and there are very few cash deposits made with us. But we do require a \$5.00 deposit and give the usual receipt and a check on its return. As to the question of a person dying, who holds the receipt, the legal representative of that estate can sign the receipt or can countersign the check. We have also quite a number of community hydrants or community taps on property in the poorer negro districts. In a great many cases the landlord pays the bill. We have a system of checking through the books every month and sending the bill as designated by the landlord, whether it comes to him or goes to the property owner. We have a number of apartment houses where the landlord carries the entire bill. For that reason it is practically the rule that the landlord designates whether it shall go to the tenant or come to him. With a proper signing up of the guarantor for the tenant, the tenant may pay the bill.

Chairman Patton: In answer to our questionnaire, "Do you require the consumer to sign a contract?" 83 replies were received; 50 answered "yes" and 33 answered "no." To the question "Do you consider this necessary, if the consumer has put up a cash deposit?" 67 replies were received, 35 answered "yes" and 32 answered "no." If a contract is necessary, let us have it, but if we can get along without a contract, even if we do lose a few dollars once in a while, it seems to me that it is better to do away with the contract.

S. H. Taylor: In New Bedford we do not recognize the tenant. We require the owner to sign the application before we put the service in the property, and, in our service book, to sign an agreement that he will abide by the rules and regulations of the department and pay the bills regularly. We also collect our water bills, $5.00 minimum charge in advance, plus the meter rental. Until the amount of water used exceeds that $5.00, they get no further bill, so that they do not have to make any deposit other than that to get it from the owner.

J. W. Crow: We collect all our money from the tenant and hold the property owner responsible only where he has put up a deposit the same as the tenant. Our minimum is $5.00 and our maximum $100. If the consumer's bill goes higher than the deposit, we raise the deposit and in that way we have no dead heads. We also make them take out the owner's deposit, a receipt which states that they agree to so and so, and this order and receipt is numbered. There is a duplicate. He keeps this receipt and on his return, if he is canceled out, or should lose this receipt, he has to sign a statement that this receipt has been lost, so that none of his folks come back later with the original receipt and take down the deposit. We also keep a record in another book of the number of this receipt, the number of the deposit, his address and the data, so that, if he should have that receipt out twenty years, we can turn back to that book and see the amount he put up, the day he took it out and the number of that deposit. We do not require him to sign a contract any more than to sign his receipt when he takes out his deposit.

Wm. Luscombe (Gary, Ind.): I believe there is an advantage in having a contract signed. Ours is a private plant and it seems to me that the rules and regulations governing consumers are more

easily enforced. It makes it uniform all around for those who are your customers. It puts you on record and serves as the basis of a contract should there be questions of dispute. We require non-property owners to make a deposit. Property owners do not. A deposit sufficient to cover about two months' consumption of water is required. Meters are read monthly.

H. M. ELY (Danville, Ill.): In Illinois the matter of deposit is regulated by the Illinois Commerce Commission. We have nothing to say about it. We require a deposit from non-property owners. Under the Commission's requirement, a deposit is required of twice the monthly billing for a period of six months or a year until they establish their credit. After the credit is established they do not require any further deposit.

CHECK VALVES ON HOT WATER SERVICES

CHAIRMAN PATTON: The first question is do you require any check valves on your service line, to keep the hot water from coming back through the meter?" Every one who requires a check valve, hold up his hand. Fourteen.

F. C. JORDAN: Ask them have they had any blow outs or any trouble like that.

CHAIRMAN PATTON: Have you had any burst hot water tanks due to the use of check valves. We have had one.

T. J. SKINKER: We require the installation of a relief valve when they install a check valve. Where the meter is damaged by hot water, we bill them. There is no law, as far as I know. We just do it and so far we have been getting by with it.

F. C. JORDAN: Do you bill the consumer where the meter has been damaged?

CHAIRMAN PATTON: Do you bill the consumer for any damage to your meter on account of hot water backing through it? How many bill the consumer for damage to meters? Apparently universal.

WM. LUSCOMBE: Where check valves on services are required, when the release valve fails to function, do you assume the responsibility of damages on that account?

MR. SHEAHAN (Memphis, Tenn.): I do not think the water department should, at any time, ask the water consumer to put a check valve on their line from the meter in. I think he is absolutely responsible if he does. Our policy is, if the meter gets hot and gets out of order, to notify the water consumer that he has to fix that meter. If he puts on a check valve it is at his risk and not ours. If we find he does not fix the meter, we will not furnish water, but I do

not think the water department ought to ask any consumer to put on a check valve.

A MEMBER: In Minneapolis we had a case where a suit was brought against us because a consumer put on a check valve and the boiler blew up and killed a man. We notified the city attorney that we did not order any check valve on this place. It was a gravel pit and they had turned on the water and blown up the boiler. The city attorney said that, if we had ordered that checked valve, we would have been responsible for any damage.

UNACCOUNTED FOR WATER

J. W. Crow (Ponca City, Okla.): We get credit for 85 per cent of the water we pump. We have 218 flush tanks and I think I can account for 85 per cent of our water.

J. F. Willett (Billings, Mont.): We have checked as high as 95 per cent. The last two years we ran to 85 per cent and there was a certain amount of water that we estimate is used in flushing sewers from fire hydrants and turned in by the city engineer.

S. H. Taylor: For the past seven or eight years we have accounted for 80 to 90 per cent of the water coming through our meters. That does not take account of the water used for fires and other unmetered duties.

Wm. Luscombe: Our meters register 82 per cent of the water we pump and miscellaneous uses we estimate will bring that up to 90 per cent.

Mr. McDowell (Charleston, S. C.): Our pumping station is located about 9 miles north of the city meters. We have Venturi meters measuring the amount of water leaving the plant and the venturi tube at the city limits measure the amount entering the city. The unaccounted for water between the city limits and the pumping station, where most of the large industries are located, will run about 90 per cent; that in the city about 88 per cent.

W. S. Cramer: There is no such thing as a 100 per cent metered city. Where you are furnishing fire protection, you have always got to make that estimation. On that basis we have unaccounted for water the last year of 11 per cent. The estimate has to be made for the fire department service in any case.

Mr. Winters: We are 100 per cent metered. We have a meter on all sprinkler systems and other connections, a check valve on

every service. For the past two years our actual meter registration that we paid for was 65 per cent of the actual water sent to the city.

Mr. SHEAHAN (Memphis, Tenn.): All water services are metered in Memphis except fire protection. Water meters account for about 70 per cent of the water we pump. We furnish the Fire Department and all charitable organizations, the City Engineering Department and public buildings with free water. This free water in most cases is metered, except the Fire Department, sprinkling system for the City and sewers and water used for the City in general. We find after making a thorough search for the difference we are able to account for all the water except probably 10 or 11 per cent. We have not been able to locate that yet. We think it is in the meter measurements and believe there is a large loss in the larger meters. We put 10 meters under a test for one hour to see how much water went through them before they began to register. Our test showed that 3 per cent of the water that passed through a meter one year in service can be wasted before the meter starts to register, if there should be a leak in the service connection. We find in our test that there have been some cases where meters 10 years in service showed no loss at all; others 10 years old would lose 20 gallons of water before they would commence to register.

We found upon investigation that a meter put in 6 years ago did not stand up as well as the meters that were made in other years. We know no reason for it, unless the material and workmanship at that period was not as good as at other times.

We find that nearly all water meters under-register from ½ to 2 per cent. If a meter bill increases during the month, the property owner will surely be there to tell you, but if the bill is down, there is nothing said. We found in our investigation that about 95 per cent of the meters were low; about 1 per cent were high. In one case we had an over-read of 8 per cent and that meter was 15 years old. By overhauling and putting in new gears, we corrected that.

I would like to ask Mr. Cramer, or any other member, if he ever tried such a test and what results they found.

W. S. CRAMER: We keep an accurate check on our meters, but I would presume that 11½ per cent unaccounted for water was just the general seepage of joint leaks or small leaks in services that do not amount to a great deal individually, but mount up in the total. I

think there will always be unaccounted for losses, even if you are metered 100 per cent.

Mr. Sheahan (Memphis, Tenn.): We have been over this thing carefully and have not allowed as much for underground leaks as we might. I made up my mind that the biggest part of that million gallons that we are short each day is not in leaks. It may be in the measurement. I think we are going to find a good part of that in the large meters. In a little place out east of Memphis they had a 6-inch hydrant and the people were using about fourth-fifths of the amount of the water that passed through that meter. They ordered it cut off. There were 16 houses left on that meter and it never registered. We finally had to take it out and put in a smaller one.

Alexander Potter (New York, N. Y.): I would like to know whether any members have any information as to this unaccounted for water, what percentage is due to under-registration, which I think is very small, what is due to leaky mains and what percentage from out services?

Mr. Winters: In our town they wash the streets with a street washer and count the tanks. I was figuring 10 per cent for dead meters and slippage on meters. We have leaks every month between the curb and the cellar, but there is more or less slippage on all meters. When I said 65 per cent, that was the actual meter registration, the actual billing for the meters. I can account for 65 per cent of my water, figuring our street washer and seepage and dead meters, especially at periods when we do no sprinkling and fall flushing.

USE OF WATER FROM FIRE HYDRANTS BY CONTRACTORS

MR. JONES (Tulsa, Okla.): I am the engineer for the water Department of Tulsa, Oklahoma. We do not allow anybody to connect on to a hydrant. We send a man there to turn on the water and the contractor has to pay that man four or five dollars a day to stand there and turn the water on or off.

J. F. CHRISTY: That is a problem in every city, large or small. What is always needed is coöperation between the construction department and the city department. When work of that kind is going on with us the water foreman sends a man out to keep in touch daily with that work and look after what is necessary. Relative to connecting to a hydrant, we have an ordinance which protects us in that respect. The hydrant is not supposed to be used for any other purpose than fire; but, if it becomes necessary, they come to our office and get a permit and we send out our own man. We have valves to connect on to the hydrant. We put a valve on, if the water is to be used for any length of time. It is not necessary for the man to stay there all the time. When putting in our sewer systems, there are many places where they are 20 feet deep. We have men go ahead with the ditching machine to remove those lines and reconnect them after the machine passes.

MR. JONES (Tulsa, Okla.): We have adopted a valve and we open the hydrant in the morning and do not close it until the contractor leaves that night. We operate the valve instead of the hydrant and you will find in the long run that it pays to do that.

ARE CONSUMERS REQUIRED TO COME TO THE OFFICE OR MAY THEY TELEPHONE IN ORDER TO GET THE WATER TURNED ON?

CHAIRMAN PATTON: Sevent y-eight replied; 35 require consumers to call at the office; 13 have made provision to handle by telephone and 30 use both methods.

MR. TRUMAN (Colorado Springs, Colo.): We will accept telephone calls, but they must be followed up by a written notice to the company to give the consumer water.

P. J. HURTGEN: Our inspector makes a report to the water division that the plumbing is o.k.; then the water can be turned on. When we get the o.k. from the plumber, we turn the water on by a call from the owner. We already have his contract, because he comes in and pays for the meter, or rather when he pays for the service, he has already signed the contract.

PATRICK GEAR: Does that question refer to new or to old services?

CHAIRMAN PATTON: This is for old service lines or old taps that have been in a number of years, but the people have been away from home or new tenants have come in and the water has been turned on. This applies to cities where the consumers pay the bill.

MR. GEAR: If it applies to the new ones, no telephone calls will do any good in our place. You must come with the cash to the office. With old ones, the telephone call is all right, if you do not owe any bills.

ALEX MILNE (Ontario, Can.): It strikes me that these questions reopen the whole problem as to who is going to pay for the water, when the word "consumer" is used. We require the consumer to come to the office and sign for the water. It is not a contract, we do not require a deposit in any case, but he must sign a turn-on order.

In case of a lawsuit, that turn-on order is a legal order in court. If a consumer signs an application for water to be turned on, he assumes liability for the payment, but we insist that the consumer must sign it. That again brings up the whole question as between the tenant and the owner. With us, all water rates become a lien on the property, if not paid, even by the tenant, but with the tenant having signed the application as a turn-on order, which becomes a legal order, we can refuse to give him water in any other house until he pays his water bill, if he defaults. I might say that we have something over 8,000 services. At the present time we have no account which is required to be written off. In the last 15 years we have had no dead accounts.

J. F. Willett (Billings, Mont.): We require only one contract, that is, signing up for your service. We consider that to be continuous for the successor or owner of the property. They are held responsible for obeying the rules and regulations of the water department. We require deposits from all tenants. From property owners, unless they have proved unfaithful to their charge, we do not require them, because we can shut those off and get action on them. We charge $5.00 minimum and an average deposit of two months on other property that runs higher bills.

Mr. Jones (Tulsa, Okla.): The Tulsa department requires a contract which can be signed at any time, but the water will not be turned on until we receive the plumber's certificate that the plumbing is o.k. That contract carries a $3.50 water bill. When that is exhausted, they are billed from then on. If it is the owner of the property he does not have to put up a deposit. If he is a renter he has to put up a $5.00 deposit. We are not taking deposits from anybody, until they move or a new account is opened in their name. The old account stands just as it was before, but, any time you move or change your residence, you must put up a deposit, if you are a renter. If you bring your credentials to the office to show that you are the owner of that property, the water is turned on without a deposit, except that on new contracts we require $3.00 in advance.

Chairman Patton: How many plants charge a turn-on fee for turning the water on after it has been shut off for non-payment? This appears to be unanimous.

DEPRECIATION RESERVES

Eugene F. Dugger (Newport News, Va.): Our Waterworks Plant and System at Newport News, Virginia, was purchased in July of last year for $3,300,000. The book value of our depreciable assets is a little over $2,300,000. We are setting up a Reserve Account of about $45,000 a year which is a little less than 2 per cent. I presume that each waterworks department has definitely determined the life of the items to be depreciated, and has worked up a schedule of depreciation for these items in order to get at a total amount which it charges off annually. This is the way the above amount was arrived at in our city. I feel that my answer to a question of this kind would be of very little help to the waterworks' superintendents in another location, because in different locations the life of certain materials is much longer than others. In other words the amount of $45,000 which we are charging on a $3,300,000 investment may not be nearly as large as an amount of $20,000 on a similar valuation located in some place where soil conditions are vastly different.

Chairman Patton: It has been the practice of a great many plants to take an arbitrary amount, 1 per cent or 2 per cent, and charge that to depreciation and create a reserve with the idea of having the plant appraised at regular intervals and adjust your books in relation to the appraised value of the plant. In small plants I believe it is more easily handled that way than by separating the different parts of the plant and charging depreciation on the different items. Our idea was to find out the usual practice in this respect. I believe I will ask a show of hands. We will find the lowest depreciation that has been customarily charged. Now I doubt if anyone would charge less than 1 per cent depreciation on a plant as a whole. I will ask how many charge 1 per cent or less? Ten. How many charge $1\frac{1}{2}$ per cent? Two. How many charge 2 per cent? Three. Is there anyone charging more than 2 per cent annually, as a whole? One.

J. F. WILLETT: I think that depends on the material of which your plant is constructed. We have three or four different kinds of pipe. Originally our pipe consisted of 25 miles of wood pipe. We took 6 per cent depreciation on the wood pipe and on various materials we take the percentage according to the life of that material. We estimate the life of the material and in our case it will run over 3 per cent.

MR. DUGGER: We charge against the Reserve Account the original cost of the pipe, hydrants, meters, etc., which are being replaced, less salvage value, if any.

JOHN CHAMBERS (Louisville, Ky.): I do not think any of the items just mentioned by this gentleman should properly be charged as depreciation. We carry that as maintenance. If you replace any piece of machinery because it becomes obsolete, that is depreciation reserve. We took out some economizers three years ago and replaced them. That was charged to depreciation. Taps taken out or replaced by a new one are charged to depreciation, but I think the items the gentleman mentioned are maintenance.

MR. DUGGER: They were allowed by the government authorities that came in and put that pump back into its original condition.

J. F. WILLETT: We charge our depreciation against the income account, and such charges as Mr. Dugger mentioned are maintenance charges.

MR. CLAYTON: We charge all maintenances of services on account of paving to our depreciation reserve, and all services which have to be replaced which have not worn out. New services are charged to a separate account, but services put in, in place of old ones not yet worn out, are charged to depreciation.

HOW ARE "BAD DEBTS" HANDLED?

CHAIRMAN PATTON: I believe you carry them into a bad debt account at the close of the year. The question is do you cancel your bad debts at the close of each quarter or each month, just carrying a memorandum, so as to collect them if you have an opportunity, or do you carry your bad debts into a "bad debt account" and at the close of each year place it into a profit and loss account? Do you cancel them each quarter by entering them on the deduction sheet, or do you carry these into a bad debt account, which, at the close of the year, is closed out through profit and loss?

MR. SHEAHAN (Memphis, Tenn.): We set aside $300 every month to cover our bad debts.

CHAIRMAN PATTON: How does that show up on your monthly report? $300.00 for bad debts each month?

MR. SHEAHAN: No, it shows that we set aside that much and at the end of the month, we charge up the bad debts.

CHAIRMAN PATTON: I think a councilman would say "You haven't any business losing $300 a month; you ought not to lose anything."

MR. SHEAHAN: I expect if we had some of the laws I have heard explained here this afternoon, we would not lose anything, but we have to go ahead and charge to the renter or consumer instead of the property owner. If we have any failures or people who cannot pay their bills, we lose it. It amounts to 0.5 per cent a year of our accounts.

CHAIRMAN PATTON: What per cent of your annual gross revenue is lost by bad debts? How many lost less then 1 per cent? Let me have a show of hands. Sixteen lost less than 0.25 per cent. How many lost as much as 0.5 per cent? Eight. It looks as if we are in the minority.

Mr. Crow: If you have a lien against the property how are you going to lose anything? We put up a deposit in my town. I think I lost $9.00 last year and my collections run somewhere around $150.000.

Mr. Carlin: Where you have a council and other city departments, say sewer flushing or something of that kind, and the money is exhausted you have to depend on a future budget. If they do not pay it, you carry it on your books. When we deal with the city departments themselves, we have more difficulty than when we deal with individuals.

C. E. Inman (Warren, O.): The only case where we lose anything is when a firm goes into bankruptcy. We cannot collect a bankrupt account.

Mr. Jones: I do not suppose we lost anything on water bills, but we lose a lot of bills from smaller cities in the neighborhood of Tulsa that call for emergency supplies. After they get the supplies we find that they have not the funds in the department to pay for them. When that year is gone they cannot pay for the water and we have to charge it off.

SEPARATE ACCOUNTS FOR VALVES, HYDRANTS AND MAINS

MR. CHAMBERS: Hydrants are entirely separate in our accounts. All the valves and appurtenances for water mains are in the mains. Fire hydrants are put in in a peculiar way. In Louisville, the water company has nothing to do with their installation or maintenance; the city charter prevents that. The installation of hydrants is done by the contractor, who has the right to tap the water company's main. All the pipe valves and plugs are charged directly to the line.

MR. INMAN: In Ohio the law reads that all new fire hydrants must be paid for by the Director of Public Safety, and they can issue a bond for the installation of those new hydrants. After the hydrant is once installed, the water department has to take care of it.

MR. SHEAHAN: We pay for everything else except fire hydrants.

MR. CHAMBERS: Why should not everything that goes into a pipe line be charged to the pipe line, except the fire hydrant?

CHAIRMAN PATTON: I think it should.

MR. CHAMBERS: I never heard of any other practice; have you?

CHAIRMAN PATTON: I don't know. At my plant, when I put in a main, I charge the main and everything connected with it to this one extension, but I am beginning to doubt the wisdom of that, because it does not give me an accurate cost per foot of main. I thought I could get a pretty good average cost per foot. It gives it closely enough by taking the hydrants, valves and everything together.

MR. CHAMBERS: Leave the hydrants out.

CHAIRMAN PATTON: I have to put in the hydrant lead and a T. We use the same trucks to haul the fire hydrant as the pipe, and I

use the same men in setting the hydrant who cut, fit and lay the pipe. It makes it rather confusing to try to separate a labor and material cost on your hydrant from the labor and material cost on your main.

Mr. Sheahan: Before we lay a main anywhere we have an estimate made of the cost of our 6-inch main laid with valves and connections. They cost about $1.35 per foot complete. In the 6-inch main, the pipe itself costs from 60 cents to 65 cents a foot; with the fittings, the lead, etc., it amounts to about $1.35; the 8-inch pipe $1.60; 10 inch $2.15 and 12 inch about $2.90. We have no rock or hard ground to go through. We put our mains down about four feet. When we dig with a trenching machine it costs about 12 cents a foot less than when done by hand. We charge the city for the connection to the fire hydrant which it furnishes. We get nothing from the city for any water used for fire protection or anything else, and the only thing we get out of it is putting in the hydrant. We put in 10 per cent for overhead in the cost.

Mr. Carlin: We are pretty successful in collecting for hydrants, but I think we collect some bills about which, if we went into court and they asked for a jury trial, we might be doubtful.

Mr. Truman: Is there any privately owned water system represented here? I would like to know how the fire hydrants are handled with the privately owned system. Does the owner of the water system furnish and install these hydrants or does the property owner buy and install the hydrants?

Chairman Patton: The customary practice with privately owned plants is for the company to buy the hydrants and the city to pay a hydrant rental.

Mr. Truman: We do not supply water in an incorporated district. We supply about 3000 users. It is a little extraordinary of course. We have recently made a proposal to our users that, if they buy the hydrants, we would install them free of charge, maintain them and furnish the water free of charge indefinitely, as long as our charter lasts. I was wondering whether that was in line with any other privately owned water system?

Chairman Patton: Are there any plants with mains outside the corporate limits of the city, where the property owners want fire protection?

Mr. Clayton: We furnish both inside and outside equipment and to the city user we make no charge for the fire hydrant and receive only the rental, but when we furnish the communities outside the city limits, they are charged up sometimes against the persons who own the property on which these hydrants are installed and sometimes there is an arrangement made by a group of people. They simply pay the rental and we furnish the hydrant free, so we have no set rule in that respect. We operate under the Public Service Commission rules in Indiana and fire hydrant charges are kept separate, but there is no division made between the main and the valve. They go into one account, but, in general, the fire hydrants are furnished free both inside and outside the corporation. The rental varies from $50 to $60 a year.

Mr. Jones (Tulsa, Okla.): Tulsa is a municipally owned plant, but we furnish water outside the city limits. We permit the property owner outside the city limits to buy the hydrant and we install it. They pay for installing it and we furnish the water and make a contract to reimburse them less the depreciation in the price of the hydrant and the lines when they come into the city. We do not get a hydrant rental.

Mr. Chambers: We do about the same thing in Louisville. We furnish a great deal of water outside the city, but the consumers have to pay for the entire cost of the main and for the cost of the hydrant, if they want it, but not for the water. They pay for everything we do outside the city.

E. W. Agar (Valparaiso, Ind.): We furnish the city hydrants free and they pay $50.00 a year hydrant rental. Outside the city the consumer pays for the service hydrant and pays a water tax. All expense outside the city is paid by the consumer. Inside the city, we furnish the city the hydrants at our cost and the city pays $50.00 a year rental.

MR. HURTGEN: We have no rental charge for hydrants but we have a per capita charge. Our per capita charge is $1.00 per capita. That amounts to about $75.00 per hydrant. Where we make extensions, we have only one outside the city, we charge up the entire extension at cost and we charge them $100 a year for hydrants and charge them otherwise for their services and meters, 50 per cent in excess of the charge we make to the city. This is of course to discourage extending mains outside the city.

J. F. WILLETT: What proportion of the distribution system is required to furnish fire protection for a city?

CHAIRMAN PATTON: In the Manual the figures run about 65 per cent in the average town. I would like to hear some of the members on that.

MR. McDOWELL: In one case I analyzed I found that it ran 45 per cent.

MR. HURTGEN: I might say that that agrees with the situation in Kenosha.

MR. WILLETT: In two or three cases I have made estimates of from 35 per cent to 45 per cent. It seems to me an injustice to put in that amount of capital and get no rentals from fire hydrants and let the consumer bear the cost of that fire hydrant rental. Some cities do that. The Public Service Commission of Montana prohibits that if it can. They require hydrant rentals to be paid on all municipally owned plants.

MR. McDOWELL: I think the public service commissions are beginning to realize, as they go into the question of rates more thoroughly, that the hydrant rental has not been high enough. I think they recognize that, but inasmuch as some of them, previous to their organization, were so small, they do not like to raise it up to the equitable amount at the present time for fear of adverse criticism. I think though the tendency is for them to allow a higher rate.

A MEMBER: With a corresponding reduction in rates to the consumer?

Mr. McDowell: No, they will only allow a reasonable return. The rate to the consumer should be reduced, but the municipality is not paying to the company an equitable amount for fire protection.

Mr. Jones: Did you say 45 per cent of your plant was fire protection?

Mr. McDowell: Of the distribution system.

Mr. Jones: What class of insurance is your underwriters?

Mr. McDowell: I do not know. I do not have much confidence in these underwriters' associations. They tell you your plant is inadequate, and you tell them you expect to lay a duplicate line because they claim there is a certain amount of risk. You are penalized because of a single line, your pumping station being twelve miles from the city, and you only have a single line. They foresee all kinds of catastrophes whereby that line will be damaged and the town cut out of water in case of a conflagration. You spend $300,000 and duplicate the line, and previous to that you ask them how much benefit those insuring will get if you spend that $300,000 and they invariably answer that your rates are too low now.

IS TYPHOID FEVER A VANISHING DISEASE?

Editorial Comment

Editorial comment in the technical press during the past few years has been justly optimistic in referring to the remarkable reduction in typhoid fever incidence in the United States. A favorite phrase has been that "typhoid fever is now a vanishing disease." It comes with considerable shock, therefore, that in the last twelve months we should have experienced two typhoid fever epidemics which in incidence surpass anything confronting us in the last century. The causes of these two epidemics, separated from each other by the Atlantic Ocean, are of special interest to water works officials and sanitary engineers.

In the fall of 1926, the City of Hanover, Germany, experienced an epidemic of gastro-intestinal disease aggregating 20 to 30 thousand cases in less than three weeks. This was followed during the early part of September by a total of 2500 cases, with 260 deaths, from typhoid fever in approximately 60 days.

A commission of experts, appointed partly by the City of Hanover and partly by the Federal Government, placed the blame, without reasonable doubt, upon a part of the public water supply. This supply was obtained from filter galleries and wells in a gravel soil, relatively unprotected against pollution by surface water. The water supply was untreated in any fashion. During flood waters the supply was heavily contaminated, with the disastrous results noted above.

During the period March 1 to July 16, 1927, the City of Montreal, Canada, suffered a typhoid fever epidemic, in which over 5000 cases occurred with 488 deaths. A special board of the United States Public Health Service reporting on the Montreal typhoid fever situation, stated "From the official record of cases and without consideration of the possible number of additional cases unattended by physicians or not diagnosed and reported, it is evident that since March 1, 1927, Montreal has suffered a severe epidemic of typhoid fever with a case incidence in proportion to population probably unprecedented by any other large city in the world within the present

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century." This epidemic beyond reasonable doubt was caused by infection distributed in the output of the milk supply from one of the dairies in the City.

These two situations appear to the writer to demand comment at this time. They carry a moral. They serve as a warning of our human frailities in control of our water and food supplies. Epidemics of enteric fever in enlightened countries do not "vanish." *They are merely held in abeyance by the most rigid control of the source, treatment and distribution of these supplies.* This control is becoming increasingly difficult with the enormously increasing pollution of practically all areas and streams by human wastes. These terrible afflictions, occurring immediately upon the gratifying announcement of the low typhoid fever death rates, may have a salutary effect. They illustrate once more that "the ghosts of environmental diseases may have been safely laid in literature, but certainly not in fact." These events throw down the gauntlet to the members of the American Water Works Association. It is to them in a large measure that the public must look to hold in check that "vanishing disease," which every now and then escapes its leash.

ABEL WOLMAN.[1]

[1] Editor, JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION; Chief Engineer, Maryland Department of Health.

SOCIETY AFFAIRS

THE ANNUAL CONVENTION

The forty-seventh annual convention of the American Water Works Association was held at the Hotel Sherman, Chicago, Illinois, on June 6 to 11, 1927, with a total of over 1600 members and guests present. These were divided as follows: Active Members, 771; Associate Members, 300; Guests, 538.

Afternoon Session, June 6. The first conference of the convention took place on Monday afternoon, when a Superintendents' Round Table Discussion was held, under the auspices of the Plant Management and Operation Division, with W. S. Patton in the chair. The subject under discussion was "Water Works Accounting,"[1] based on a series of questions prepared for consideration.

Meetings of the Standardization Council, George W. Fuller, chairman, and of Committee No. 1, Standard Methods of Water Analysis, were also held during the afternoon.

A musicale and reception for the ladies was held under the auspices of the local committee in the afternoon.

An informal evening reception and dance in the grand ball room, under the auspices of the Water Works Manufacturers' Association, closed the day.

Morning Session, June 7. The convention was officially opened on Tuesday morning at 9:30, with the president, Allan W. Cuddeback, in the chair. In his opening address, Mr. Cuddeback said he believed the convention would be the largest and best the association has ever held. He called attention to the great growth of the association in the past few years, it now having 2 divisions, 15 sections and 2 affiliated societies. He referred to the great work accomplished through the Standardization Council as a guiding authority, both to the body itself and to its committees.

One of the most important actions taken was the formation of a committee to gather material for revision of the Manual of Water Works Practice, preparatory to the issuance of a second edition.

[1] This Journal, page 455.

In closing he urged the members to realize their individual responsibility and aid in this revision.

Secretary Beekman C. Little then read the list of new officers elected as follows:

President: James E. Gibson.

Vice-President: William W. Brush.

Treasurer: George C. Gensheimer.

Trustees: District No. 2: Seth M. VanLoan. District No. 8: L. R. Howson. District No 9: George W. Pracy.

The reports of officers followed, including that of the secretary and the treasurer, the electrolysis fund, and the budget committee. All of these were accepted and ordered filed.

The Diven Memorial Medal, given to the member who has done most for the association during the current year, was awarded, in an appropriate speech, by Mr. Milne, chairman of the committee on award, to Arthur E. Gorman, chief sanitary engineer, of the Chicago Department of Public Works, and secretary of the local convention committees.

The medal was presented to Mr. Gorman by President Cuddeback. The recipient said in accepting it that he considered it not as a personal award, but as a recognition of the work of the committees of the convention. He referred to the splendid coöperation he had received from both the American Water Works and the Water Works Manufacturers' Associations.

A handsome gavel was presented to the retiring president by Mrs. Charlotte Diven, widow of former Secretary Diven, in memory of him.

The report of the Standardization Council was given verbally by its chairman, George W. Fuller. He announced two new committees, one on standpipes and water towers, J. E. Gibson, chairman, and the other on steel pipe lines, J. Waldo Smith, chairman.

Mr. Fuller described at some length the work in connection with the international committee of the League of Nations on standard methods of water analysis, referring to the coöperation between American and foreign water works men.

He spoke of the work accomplished by committee No. 19, on boiler feed studies, under the able chairmanship of Sheppard T. Powell.

Mr. Fuller pointed out the great opportunities for service which were in the grasp of the association, along the line of developing public opinion as to the work of the men who regulate the activities of

public utilities, especially the water works. The association can do much also in developing the better class of men at the heads of municipal plants and by increasing more satisfactory relations between such plants and their consumers. He hoped that the time would soon come when not only the number of sections of the association would be increased, but also that regional meetings of several sections would be held.

He announced that the abstracts of articles in the technical journals had been approved and would be continued. In referring to the Manual of Water Works Practice he said that a second printing had been accomplished last October, and that 571 of the second 1500 had already been sold. A new committee on the revision of the Manual had been formed. A second edition of the Manual would depend entirely upon the interest and assistance all of the members of the association gave this committee.

The only paper of this session was read by W. D. Collins,[2] on "Quality of Water and Industrial Development;" discussion by Bartow, Brush, McDonnell and others.

Afternoon Session, June 7. President Cuddeback in the chair. The following papers were read: "The Underwriters' Laboratories and Water Works Equipment," by Dana Pierce. "Restoration of Water Service in Miami Following the Hurricane," by H. H. Hyman. "The Chicago Avenue Tunnel Construction Methods," by John S. Dean. "Chlorination Control in Chicago," by A. E. Gorman. "The New Water Supply of Amarillo, Tex.," by Wynkopp Kiersted, Jr. Mr. Gorman's paper was discussed by Bartow, Brush, Howard and Gorman, and Mr. Kiersted's by Alexander Potter.

Evening Session, June 7. The convention was welcomed by Richard W. Wolfe, commissioner of public works of Chicago, in the absence of Mayor Thompson. The only paper was on "A Program for Improvement of Water Service in Chicago," by Myron B. Reynolds.[3]

At 11:30 a.m., June 7, the ladies were taken on a trip to Marshall Field Store, with style show and luncheon, compliments of the local committee. In the evening there was a card party, compliments of the Water Works Manufacturers' Association. This was in charge of Mrs. W. C. Sherwood and committee.

Morning Session, June 8. President Cuddeback announced that

[2] Journal, August, 1927, page 259.
[3] Journal, August, 1927, page 163.

the following officers had been elected for the plant management and operation division; President, W. E. MacDonald; vice-president, Thomas L. Amiss; secretary, R. B. Simms; directors, Thomas R. Henderson and Samuel B. Morris.

Four papers were read at this session, as follows: "Distribution System of the Chicago Water Works," by J. B. Eddy. "Legal Decisions Affecting the Financing of Water Utilities," by Cecil F. Elmes; discussed by J. W. Alvord and E. W. Bemis. "Public Relations," by Daniel T. Pierce,[4] read by C. A. Emerson, Jr. The final paper was by F. B. Leopold, on "Duplex Filter Bottoms." The paper on "Public Relations" was discussed by Denman, Henby, Hopkins, Leisen and others.

Afternoon Session, June 8. The afternoon session was short, on account of a boat ride scheduled at four o'clock. The first paper was by H. F. Wiedeman, on "The New Water Works Plant at Spartanburg, S. C."

The second paper was by D. C. Grobbel, on the "Application of Machines for Water Consumers' Accounting Problems." This paper was discussed by D. É. Werner. The final paper of the session was by William W. Brush, on "Compensation of the Executive and Technical Forces Employed in Water Works and Other Utilities."

As Mr. Brush was about to begin the reading of his paper, President Cuddeback announced the sudden death in the hotel, of Charles R. Wood, of R. D. Wood & Co., and that, in consequence, the smoker scheduled for that evening, would not be held.

The nominating committee reported the following names of candidates to be voted upon for offices during 1928–1929: For president, William W. Brush; for vice-president, Jack J. Hinman Jr.; for trustees: District No. 1, C. D. Brown; District No. 2 Stephen S. Taylor; District No. 6, John Chambers.

At 4 p.m., the entire convention was taken on board a lake steamer and given a two-hour sail on Lake Michigan, returning via the Municipal Pier at about 6 p.m. This was by courtesy of the Chicago local committee.

In the evening there was a theatre party for the ladies, compliments of the Water Works Manufacturers' Association, and under the charge of T. R. Kendall.

[4] Journal, August, 1927, page 262.

Morning Session, June 9. The morning session of Thursday was taken up by a symposium on Well Water Recessions. Jack J. Hinman, Jr., was in the chair. The first paper was a general review of the subject, treated by M. M. Leighton, and discussed by G. C Habermeyer.

At the conclusion of the discussion at the Morning Session by G. C. Habermeyer, in connection with the "Symposium on Well Water Recessions," President Cuddeback took the chair and a series of resolutions were introduced as follows, all of them being adopted as read:

RESOLUTION ON THE DEATH OF CHARLES R. WOOD

WHEREAS, the late Charles R. Wood departed this life the 8th day of June, 1927, at the Hotel Sherman, in the City of Chicago, and during the 47th Annual Convention of the American Water Works Association in which he was taking an active interest, and

WHEREAS, the deceased has for many years been a very active and stimulating influence in the councils of our Association, having given of his best to the advancement of its interests, and

WHEREAS, we, members of this Association will miss his counsel and advice in our circle, and his friendship and good fellowship in our social relations, therefore be it

Resolved that we, the members of the American Water Works Association, in session at our annual meeting in the Hotel Sherman, Chicago, Ill., June 9th, 1927, regret his untimely demise and hereby register this expression of our loss, and it is

Ordered that this Resolution be spread upon the minutes of this meeting, and that a copy of these Resolutions be engrossed and forwarded to our deceased member's family.

RESOLUTION ON WATER WASTE POLICY

WHEREAS, we, the members of the American Water Works Association are in convention assembled at Chicago considering matters relating to the water supply problems of municipalities; and

WHEREAS, it is our purpose to aid in serving the public, not alone in the supply of water, but in the conservation and treatment of water; and

WHEREAS, pure air and water are paramount necessities of human like; and

WHEREAS, a supply of pure water is a necessity to every city; and

WHEREAS, the use of water in reasonable amounts is necessary for the conservation of the natural resources of the country; and

WHEREAS, unreasonable use of water by wilful or ignorant waste is a matter which it has been the function of the members of this Association to control in their due course of business; and

WHEREAS, experience in such control has shown that waste can be reduced without any injury to the water users by the employment of adequate methods of control; and

WHERAS, such useless waste not only extends the adequacy, but also reduces the cost of operation of the works, gives better service and better pressure, not alone for ordinary uses, but during fire and emergencies; and

WHEREAS, to obtain a pure supply from a source where surface water is used, modern practice suggests the employment of water filtration, particularly where pollution is possible and where turbidity may be encountered, and such filtration becomes far more practicable and is much less expensive to the users of water where the waste has been eliminated;

Now, Therefore, Be It Resolved, that it is the sense of the American Water Works Association assembled in convention in Chicago on June 6 to 11, 1927, that it should be the policy of all water works to reduce waste, whether such waste occurs through leakage in mains, wasteful use or other causes; and that such policy will increase the usefulness of the works by giving better service, and make it easier and more practicable to finance, build and operate water supply works, and filter the water supply, if need be.

RESOLUTION ENDORSING ACTION OF FLOOD CONTROL CONGRESS

WHEREAS, we, members of the American Water Works Association, are in convention assembled at Chicago considering matters relating to the water supply and problems of municipalities; and

WHEREAS, in the past two months record floods have occurred on the Mississippi River and its tributaries bringing untold suffering to great numbers of human beings and loss of property, amounting to a great catastrophe, and

WHEREAS, many of our members are operating water works on the Mississippi River and its tributaries which have been threatened or seriously damaged or put out of operation by the present floods; and

WHEREAS, a flood control congress was called by the Mayors of Chicago, New Orleans and St. Louis, which met in Chicago last week and was attended by public officials, engineers and representatives of all parts of the Mississippi Valley; and

WHEREAS, said Congress deliberated at length on the problems involved, and as a result passed certain resolutions;

Now, Therefore, Be It Resolved, that the American Water Works Association do endorse said resolutions which are as follows:

WHEREAS, the time is here for the Federal Government to attack the flood problem in a broad and comprehensive way because of the present Mississippi Valley disaster, the greatest of its kind in the Nation's peace time history, resulting in an incalculable amount of damage to life and property, and

WHEREAS, the need for a comprehensive plan of National flood control is made apparent by this disaster and there are in general three major proposals for flood relief set up by competent authorities, viz., levees, spillways or bypass outlets and storage reservoirs, all of which should be considered, and

WHEREAS, it is contended that this problem cannot be adequately met by the application of any single remedy and that levees, spillways and reservoirs should be used in combination where practicable, together with such additional remedies as may from time to time be developed; and

WHEREAS, floods in the Mississippi basin have not only brought disaster to those immediately concerned, but have resulted in economic loss to the

whole nation, and the people of this country now demand that effective and permanent remedies be applied and they will willingly approve the expenditures of the public money necessary to this end.

Therefore, Be It Resolved, that the Flood Control Conference, assembled at Chicago, Illinois, does hereby declare that the control of the flood waters of the Mississippi River and all its tributaries is a national problem and that the sole responsibility therefor should be assumed by the National Government; and

Resolved Further, that we urge immediate and effective relief be extended to all present sufferers; that the measures which may be recommended by existing federal agencies for relief to the lower valley, so as to protect it against a recurrence of the present disaster, be carried out promptly, and that the necessary appropriations therefor be made, and

Resolved Further, that, without delaying the carrying into execution of such imperatively necessary measures as may be recommended by existing governmental agencies, the President of the United States is requested to call a Conference for the purpose of formulating, in conjunction with such governmental agencies, a comprehensive plan for navigation and permanent flood control; said Conference to be composed of army engineers, civil engineers, conservationists, geologists, financiers, agriculturists and other experts representing the various interests of our country, and

Resolved Further, that the Conference petitions the President of the United States and the Congress to energetically undertake and carry to a speedy conclusion comprehensive and effective measures for permanent flood control of the Mississippi River and all its tributaries.

RESOLUTION ENDORSING CONTINUANCE OF AMERICAN COMMITTEE ON ELECTROLYSIS

Whereas, the American Committee of Electrolysis has requested a referendum to its constituent members as to its continuance, and

Whereas, your Committee representing the A. W. W. A. on the American Committee of Electrolysis believes, in view of recent trends in Electric Distribution, it is advisable to continue said Committee and to reaffirm the societies basic position on certain phases of the electrolysis problem.

Therefore, Be It Resolved, by the American Water Works Association in Committee assembled; (1) That this Association endorse the continuance of the American Committee on Electrolysis as a proper agency for promoting inter utility contact and coöperation on electrolysis matters and for the study and consideration of general engineering aspects of the electrolysis and soil corrosion problems, fostering of research along these lines and keeping in contact with all activities in the electrolysis and soil corrosion field, and further

Be It Resolved, (2) That this Association on fundamental engineering grounds definitely opposes the use of pipe drainage as a primary method of electrolysis mitigation, but has no serious objections to its use as a supplementary mitigative measure in situations where the railway, or other distribution systems have obtained their maximum operating economy by the

adoption of suitable primary methods and where pipe drainage can be shown to be the most practical means of taking care of any small residual stray current.

RESOLUTION MODIFYING STAND OF ASSOCIATION AS TO THE USE OF GROUNDING OF SECONDARIES OF LIGHTING TRANSFORMERS

WHEREAS, this Association in 1920 endorsed the grounding of the secondaries of lighting transformers on water pipes as promoting the safeguarding of life and property without hazard to the pipe systems, and

WHEREAS, experience with certain grounding practices, and certain trends in electrical distribution methods has shown that hazards to pipe structures and to water works employees have been and will be set up; and

WHEREAS, certain trends in water works construction methods may seriously affect the conductivity of the water piping systems;

Be It Resolved, that the American Water Works Association in convention assembled hereby modifies its 1920 endorsement of the grounding of the secondaries of lighting transformers as follows:

(1) The American Water Works Association approves the practice of grounding the secondaries of lighting transformers on water pipes for the purpose of safeguarding life and property, provided that appreciable electric current flows over such ground connections only during comparatively short and infrequent intervals when the ground connections are fulfilling their specific protective purposes, and provided that such ground connections impose no responsibility upon the pipe owning company.

(2) The American Water Works Association is opposed to the use of water pipes as electrical conductors, except as noted above, and since experience with certain power distribution practices which have come into use has shown that grounding may result, and in many cases has resulted in hazard to the pipe structures and water works employees, it hereby withdraws its former general endorsement of grounding on water pipes.

At this point Mr. Hinman again assumed the chair and the symposium on Well Water Recessions was resumed. The papers concluding this subject, which were completed at the Friday morning session, were: Application to Iowa, James H. Lees;[5] to Wisconsin, Leon Smith; to Indiana, Charles Brossman; "Sanitary Safeguards in Development of Ground Water Supplies," by W. Scott Johnson, and "Analysis and Tests for Capacity of Water Supplies from Sand and Gravel Formation," by W. G. Kirchoffer.

James E. Gibson reported progress as chairman of the committee on Steel Standpipes and Water Towers.

President Cuddeback expressed great appreciation of the manner in which the members had supported him during his administration

[5] Journal, September, 1927, page 314.

and especially in this convention. He then called the President-elect, James E. Gibson, to the chair.

President Gibson announced that the executive committee had decided that the 1928 convention would be held on the Pacific Coast.

The Nicholas Hill cup, for the greatest percentage of increase in section membership during the year, was awarded to the Florida Section. In doing so, President Gibson referred to the large membership of the California Section, which has grown to be one of the largest sections of the association.

A paper on friction losses in cement-lined and tar coated pipe was read by Melvin L. Enger.[6]

SUPERINTENDENTS' ROUND TABLE DISCUSSIONS

Round Table Discussions under the auspices of the Plant Management and Operation Division, were held in the Crystal Room on Thursday and Friday afternoons, with W. S. Patton, in the chair. At the meetings the printed questions were taken up and thoroughly discussed. A number of other matters of interest to superintendents and operators were considered.

Banquet and Dance. On Thursday evening, June 9, a banquet and dance was held in the Grand Ball Room of the Sherman, considerably over two thousand being present. A toast was offered by John W. Alvord to the Old Water Tower in Chicago, the hall being darkened and a representation of the tower, illuminated with spot light and flanked by the American and Canadian flags, being shown. Dancing till the early hours of the morning concluded the entertainment, under the auspices of the Water Works Manufacturers' Association.

The ladies were given a bus ride through parts of Chicago, with luncheon at the Edgewater Beach Hotel. The bus ride was with the compliments of the local committee and the luncheon with compliments of the Water Works Manufacturers' Association in charge of Mrs. W. C. Sherwood and committee.

Morning Session, June 10. Five papers were read. "Modern Pumping Station Design and Its Probable Future Development," by A. L. Mullergren.[7] "Present Day Tendency to Use Electric Pumps as Standbys in Steam Operated Stations," by D. E. Davis; "Water Hammer, Its Cause and Control," by Loran D. Gayton;

[6] This Journal, page 409.

[7] Journal, August, 1927, page 180.

"Protection of Sub-Surface Structures Against Freezing," by S. L. Bleich. "The Graphic Water Level Recorder—An Aid to More Efficient Operation of Reservoirs and Filter Plants," by G. C. Covert.

Afternoon Session, June 10. The following papers were read. "The Story of Chlorine," by Robert T. Baldwin;[8] "Recent Developments in Water Pipe," by Ralph R. Silver; "Sedimentation Studies of Turbid American River Waters," by A. W. Bull and G. M. Darby; "Seven Years' Observation of Slow Sand and Mechanical Filtration at Toronto," by A. U. Sanderson.

The final number on the program was the progress report of Committee No. 3, on "Practicable Loadings for Purification Processes." This was read by the Chairman, H. W. Streeter.

BOILER FEED WATER STUDIES MEETINGS

Morning Session, June 8. The papers read were "Progress Report of the Activities of the Boiler Feed Water Studies Committee for 1926 and 1927," by Sheppard T. Powell; "Priming and Foaming of Boiler Waters," by C. W. Foulk; "Boiler Feed Water Treatment from a Manufacturer's Viewpoint," by J. B. Romer; and "Zeolite Water Treatment in a Large Central Heating Plant," by Alfred H. White, J. H. Walker and Everett P. Partridge.[9]

Afternoon Session, June 8. "The Value of Boiler Water Treatmnet to the Mechanical Department," by J. F. Raps; "Water Treatment from the Standpoint of Railroad Efficiency," by E. M. Grime;[10] and "Treatment of Locomotive Feed Water from the Chemical Standpoint," by W. M. Barr.

All of these papers were freely discussed.

WATER PURIFICATION DIVISION

The first gathering of the Water Purification Division was at a dinner in the Bal Tabarin of the Hotel Sherman on June 8, at 7:30 p.m. One hundred and thirty eight were present. N. J. Howard presided. The members entertained themselves under the leadership of Wm. J. Orchard. Brief addresses were made by the Chairman and Edward Bartow, Arthur E. Gorman, Jack J. Hinman and Harry E.

[8] This Journal, page 417.

[9] Journal, August, 1927, page 219.

[10] This Journal, page 432.

Jordan. A business session followed. A motion by R. C. Bardwell that "The Chairman appoint a committee of five to study, criticize and suggest additions to the sections of the Manual relating to water purification, and report to the Division at its next meeting" was passed. This committee is understood to function as a part of the general committee on study of the Manual of which Frank C. Jordan is Chairman. It was left to the incoming Chairman to appoint the committee. A discussion followed concerning the activities of the section and methods that might be used to improve its activities.

The technical sessions of the Division were held on June 9 and 10 and the papers presented were as follows:

Morning Session, June 9. "Note on the Decolorization of Soft Waters," by Robert Spurr Weston. "Sodium Aluminate Solution as an Adjunct to Alum Coagulation," by C. H. Christman. "Studies of Double Coagulation at Cincinnati," by Clarence Bahlman. Discussion opened by F. Holman Waring. "New Developments in Water Softening," by C. P. Hoover. "Pre-sedimentation and Basin Detention at St. Louis," by John D. Fleming. 250 present.

Afternoon Session, June 9. "Some Operating Problems in Connection with Purification of Lake Michigan Waters," by Paul Hansen. "The Extension of Aeration in Water Purification," by W. S. Mahlie. Discussion opened by Wellington Donaldson. "A Review of Differential Methods for the Coli-Aerogenes Group of Bacteria," by S. A. Koser. "The Study of the Significance of the Test of Capillarity of a Sand as a Measure of Its Permeability," by R. G. Tyler. "The Graphic Presentation of Analytical Data and a Novel Method of Reporting such Data by Means of Graphs and Charts," by A. J. Authenreith. 250 present.

Morning Session, June 10. Gas Wastes, Symposium on Tastes and Odors. "Coöperative State Control of Phenol Wastes Pollution on the Ohio River Watershed," by E. S. Tisdale. "Progress in Control of Oil Pollution," by Almon L. Fales. "Some Quantitative Studies of Phenols in Water Supplies," by Wellington Donaldson and R. W. Furman. "Recent Improvements in the Art of Pre and Super-Chlorination," by Linn H. Enslow. Discussion by Paul Hansen, D. H. Rupp, A. E. Gorman, D. M. Bakke, F. Holman Waring, C. R. Cox and H. E. Moses. Progress Report on Committee on Standard Methods of Water Analysis, by Jack J. Hinman, Jr. 200 present.

At the close of the session on June 10, the nominating committee,

consisting of F. W. Green, Charles R. Cox and Almon L. Fales (Chairman), reported their suggestions for officers of the division as follows:

For chairman, Wellington Donaldson;

For vice-chairman, Wilfred F. Langlier;

For secretary-treasurer, Harry E. Jordan;

For executive committee, William Gore, George Spaulding and Norman J. Howard.

Their election was moved and carried unanimously.

ABSTRACTS OF WATER WORKS LITERATURE

Frank Hannan

Key: American Journal of Public Health, 12: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

The Softening of Hard Waters. P. Wiegleb. Z. Spiritus-ind, 49: 10, 14–5, 1926. From Chem. Abst., 20: 1876, June 10, 1926. Methods for determining hardness and eliminating lime salts described. Sodium chloride in presence of magnesium oxide is harmful, as magnesium chloride formed is hydrolyzed to hydrochloric acid, which attacks iron, forming iron chloride, which, in presence of oxygen, generates more hydrochloric acid. Iron usually exists in water as ferrous carbonate, which is converted to ferric hydroxide in presence of oxygen, liberating carbon dioxide. Water containing much iron and oxygen should therefore not be used, as corrosion will result. Oxygen is removed by adding iron.—*R. E. Thompson.*

Lime—Its Use in the Treatment of Industrial Wastes. S. E. Coburn and E. S. Chase. Rock Products, October 31, 42–3, 1925; Pub. Health Eng. Abst., March 20, 1926. From Chem. Abst., 20: 1876, June 10, 1926. Lime is used as precipitant, for acid neutralization, pH control, and as deodorant. —*R. E. Thompson.*

Denitification in Oxidizing Media. E. Parisi. Ann. chim. applicata, 16: 40–5, 1926. From Chem. Abst., 20: 1878, June 10, 1926. In purification of contaminated water, the greater the aeration the greater the loss of nitrogen as free nitrogen, because aeration favors the formation of nitrites, which react with amino acids liberating nitrogen.—*R. E. Thompson.*

The Chloramine Treatment of Pure Water. B. A. Adams. Medical Officer, 5: 6, 55–7, 1926; Pub. Health Eng. Abst., March 20, 1926. From Chem. Abst., 20: 2036, June 20, 1926. Chlorine and ammonia, when used in right proportions in water containing phenols, are taste preventive. Sterilization is retarded, but is ultimately more efficient.—*R. E. Thompson.*

Waste and Preservation of Material. H. L. Meurer. Z. Ver. deut. Ing., 70: 461–7, 1926. From Chem. Abst., 20: 2035, June 20, 1926. Painting affords only temporary protection against corrosion, because of formation of fine cracks during drying and polymerization of paint vehicle. Pigments themselves often act as catalysts, hastening formation of rust. Shortcomings of galvanizing, sherardizing, electrolytic deposition, etc., are limitations of size

and shape of object that can be treated, non-adherent zinc coating, and formation of intermediate layer of zinc-iron alloy that later causes trouble. Claimed that spray or atomizing process, in which zinc wire is melted by surrounding flame of hydrogen and oxygen, or other inflammable mixture, by use of "pistol" designed for purpose, is free from these objections. When object so coated is to be exposed to corrosive liquids, a further layer of paint is needed.—*R. E. Thompson.*

Purifying Water Blown Off from Boilers. S. Otis. U. S. 1,582,300, April 27. From Chem. Abst., 20: 2037, June 20, 1926. Blown-off water (e.g., from locomotives) while still at high temperature is treated with reagent such as sodium carbonate or lime and with added fresh water, and is then subjected to sedimentation and filtration. Treated water is reused in boiler.—*R. E. Thompson.*

Protection of Concrete Against Alkali. E. C. E. Lord. Public Roads, 6: 251, 1926. From Chem. Abst., 20: 2056, June 20, 1926. Coating of portland cement cylinders with tar or paraffin protects them from action of 3 per cent sodium sulfate-magnesium sulfate solution over period of two years.—*R. E. Thompson.*

Water for Paper. Jesse E. Minor. Paper Trade J., 82: 15, 60–2, 1926. From Chem. Abst., 20: 2072, June 20, 1926. Discussion of effect of pure water on cellulose fibre structure and of effects of salts which occur as impurities in mill water on process of changing raw fibres into paper construction.—*R. E. Thompson.*

The Action of Sulfate Water on Concrete. A Summary of Tests of Specimens Immersed for One Year in Medicine Lake, S. Dak. D. G. Mills. Public Roads, 6: 174–9, 183, 1925. From Chem. Abst., 20: 2056, June 20, 1926. Cylinders were immersed for one year in the Lake water, salt content of which was 2.34–4.72 per cent, chiefly magnesium and sodium sulfates. High-alumina and standard portland cement cured in steam at 212°F., were unchanged at end of one year. Standard portland cement cured in water vapor at 155°, 100° and 70°F., showed marked decrease in strength after exposure. In some cases admixture of blast-furnace slag, calcium chloride, Cal, and Ironite improved the resistance.—*R. E. Thompson.*

Analysis of Water for Use in Making of Paper. Jesse E. Minor. Paper Trade J., 82: 15, 62–5, 1926. From Chem. Abst., 20: 2072, June 20, 1926. Discussion of standard methods of water analysis with view to simplification and greater adaption to paper-mill use (exclusive of water for steam boilers). —*R. E. Thompson.*

The Adsorption of Soluble Salts Through Corrosion- and Rust-Protective Color Films. Hans Wolff and G. Zeidler. Farbe u. Lack, 1926 184. From Chem. Abst., 20: 2080, June 20, 1926. Experiments were carried out as follows: Paints were prepared of linseed varnish 90 g., sodium chloride 10 g.,

and pigment 167 g., pigments employed being zinc oxide, lithopone, white lead, micaceous hematite and a high ferric oxide red. Paints were applied on glass panels, dried 12 days and placed in water. The number of hours before 100 per cent of sodium chloride had been dissolved from film was as follows: zinc oxide 180, ferric oxide red 43, lithopone 76. With white lead 98 per cent was dissolved in 384 hours, and with hematite only 66 per cent in 574 hours. No explanation given.—*R. E. Thompson.*

The Shandaken Tunnel. R. W. Gausmann. Proc. Am. Soc. Civ. Eng., **53:** 5, 681–706, June, 1927. The Shandaken Tunnel, forming a part of the Catskill Water Supply of New York City, extends between Prattville and Shandaken. It is about 18 miles long, horseshoe-shaped and concrete-lined, with inside dimensions of 11 feet 6 inches in height by 10 feet 3 inches width, and a computed capacity of 650 million gallons daily. The paper recounts the development of the project and the geology of the region. The actual construction work is covered in detail. Seven shafts were used and the tunnel was driven both ways from all shafts except 1. Three methods of driving were used: the top heading, the full-face heading, and the bottom heading. In sound rock most of the tunnel was driven with a top heading with a bench from 40 to 50 feet long. In unsound rock, where support was required up to the face, the full-face heading, combined with a mechanical mucker, permitted the most satisfactory progress. Dupont gelatine low-freeze dynamite was used as it appeared to give the smallest amount of objectionable fumes. The tunnel was lined with concrete throughout, placed from the shafts. It was mixed on the surface, poured through a pipe into cars at the foot of the shart, and hauled to the forms. The invert and side-walls were placed by hand, while the arch was placed with a "concrete gun." The entire tunnel, including the Venturi meter and sluice-gates, cost $12,292,411. —*John R. Baylis.*

Water Department Accounting Methods. W. C. Hail. Public Works, **58:** 142–143, 1927. A concise presentation of important requirements of an adequate water department accounting system.—*C. C. Ruchhoft.*

Tastes and Odors in Public Water Supplies. Francis E. Daniels. Water Works, **66:** 197–199, 1927. A review of the tastes and odors problem with special reference to tastes caused by fresh water plankton and copper sulphate treatment.—*C. C. Ruchhoft (Courtesy Chem. Abst.).*

Municipal Sanitation in Virginia. Richard Messer. Mun. & County Eng., **72:** 122–125, 1927. Over 900,000 people are furnished with chlorinated water and many of the cities are over 90 per cent sewered. For 1925 typhoid death rates per 100,000 in Virginia were as follows: (1) Cities over 25,000, six; (2) Cities 1,000 to 5,000, seventeen; (3) Communities of 500 to 1,000, twenty-eight; (4) Rural, fourteen.—*C. C. Ruchhoft (Courtesy Chem. Abst.).*

Public Water Supplies in Colorado. Dana E. Kepner. Public Works, **58:** 168–169, 1927. Colorado has 105 municipal water supplies taken from

surface sources, 80 from ground sources, and 15 from combined sources. Three towns have dual supplies. Hardness varies from 25 to 900 p.p.m. A list of supplies having artificial treatment is given.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Water Taps by Whom Made and Costs. Anon. Water Works, **66**: 137–139, 1927. Data given as to who pays for the water tap and as to who does the work on it in New York municipalities; compiled by the New York State Bureau of Municipal Information.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Chlorination Operations at Ashokan Headworks. William W. Brush. Water Works, **66**: 130–133, 1927. Chlorine for the New York City Stations is received in multiple unit tank cars. Each unit weighs 3400 pounds and contains 1 ton of chlorine. Special unloading and handling equipment is described for placing the one ton containers in a vertical position on platform scales in the chlorinator room. These containers reduce the cost of shipment, require less labor in handling, are safer than the 150-pound cylinders and reduce the chlorine cost from 5¼ to 4 cents per pound.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Chicago's New Intake Funnel. Anon. Water Works, **66**: 183–192, 1927. This project includes 7300 feet of 16-foot tunnel, 9100 feet of 13-foot tunnel, four shafts 12 feet in diameter, one new crib, the destruction of the Two Mile Crib, and the installation of machinery to carry on the tunnel work and operate the system after it is completed. A description of the mining methods, drilling, mucking machine, switching equipment, repair shop, and other details of the construction methods used are given. Detailed cost accounts of the work are kept and several tables of costs which apply to sections of the work are given.—*C. C. Ruchhoft*.

Water Softening at Columbus, Ohio. Charles P. Hoover. Water Works, **66**: 223–224, 1927; Public Works, **58**: 208–209, 1927. Plant operating results showed that the hardness at Columbus could be reduced from 289 to 60 p.p.m. when 5 grains per gallon of alum were used without using any excess of lime or soda ash. It was found cheaper to remove the carbonate hardness with lime than by means of zeolite. However, the non carbonate hardness can be removed by zeolite at a cost one-half that of soda ash treatment. Present plans are to treat the water with lime and alum and, after mixing and passing through settling basins to remove the precipitated carbonates, carbonate it at the end of the settling basins. It will then pass to the filters and part or all of it, depending upon the amount of permanent hardness desired to be removed, will be passed through a zeolite filter.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Practical Application of Inhibitors in Pickling Operations. F. N. Speller and E. L. Chappell. Chem. and Met. Eng., **34**: 7, 421–3, July, 1927. The action of inhibitors in decreasing rate of attack on metals by acids is discussed. Certain inhibitors give very good protection to the metal while at

the same time reducing the attack on rust and scale very little. Certain organic compounds such as quinoline (C_9H_7N) and quinoline ethiodide ($C_9H_7NIC_2H_5$) are very effective. Experiments indicate that some of the acid sludges which are formed during the sulfuric-acid wash of petroleum and coal tar hydrocarbons are also very effective inhibitors.—*John R. Baylis.*

Removing Rust from System with Piping Acid. Chem. & Met. Eng., 34: 7, 423–4, July, 1927. Extracts from a paper by SPELLER, CHAPPELL, and RUSSELL presented before the Am. Institute of Chem. Engrs. at its Cleveland meeting. The rust was cleaned from the inside of the piping of a 35-story office building in New York City. Some of the pipes had stopped up entirely with rust and in others the flow of water had been greatly reduced. A practical means of removing the rust was found in a strong acid solvent which dissolved the rust without injuring the pipe. The plan of cleaning was to cut off a certain section of the piping, drain out the water, and fill the piping with the rust solvent, running it in by gravity from a special connection. The solvent dissolved the rust in from 5 to 6 hours. As the solvent in the pipe was used up in dissolving the rust it was drawn off and more added. At the end of the 6-hr. period the pipes were flushed with clean water. The rust solvent was a strong hot solution of hydrochloric acid to which an inhibitor was added to protect the steel.—*John R. Baylis.*

NEW BOOKS

Water Resources Paper No. 50, The Dominion Water Power and Reclamation Service, Department of the Interior of Canada. Volume deals with the surface water supply of Canada and presents the results of investigations made by the Dominion Hydrometric Survey during the climatic year from October 1, 1924, to September 30, 1925, in the provinces of Alberta, Saskatchewan and Manitoba, extreme Western Ontario and the Northwest Territories comprising the Arctic and Western Hudson Bay Drainage and Mississippi Drainage in Canada. The report contains a short explanation of the purpose and scope of the work and 210 pages of stream flow data, with an index map of the territory included showing the location of gauging stations. The report may be obtained free of charge by application to the High Commissioner for Canada, Canadian Building, Trafalgar Square, London, England, or to the Director of the Dominion Water Power and Reclamation Service, Ottawa, Canada.

Oil Engine Power-Plant Handbook. Published by Oil Engine Power, New York, N. Y. Second Edition. This book deals with oil engine installation essentials, the importance of clean air in engine rooms, the erection and maintenance of alternating current generators, generators for oil engine drives, Diesel and oil engine lubrication, cooling water and its treatment, using heat of exhaust gases for beneficial work, purification of lubricating oil, useful operating hints and diagnosis of various indicating diagrams, routine care of air compressor, gasket and packing materials, valve timing on

four cycle engines, various belt drives for oil engines, oil engine construction and operation—an outline of principles and practice, operating economies, etc.

Erectors, operators and prospective purchasers may gain useful information from this book.—*Huldreich Egli*.

Sketches and Workings of Oil Engines. JULIUS KUTTNER. Freeman-Palmer Publications, New York, N. Y. Written in an extraordinary manner and with clearness. The numerous illustrative sketches are particularly helpful to the student.

Chapter 1 distinguishes oil engines from other internal combustion engines. Their relative efficiencies, working temperatures and pressures are described and diagrammatically represented.

Chapters 2 and 3 are treatises on fuel supply to oil engines. In particular Chapter 2 deals with airless, whereas Chapter 3 deals with air, injection types. In addition to numerous illustrations of spray arrangements, reference is made to several useful papers dealing with the subject. The reproductions of photographs of spray experiments are illustrative. Even though there are diversities of opinions as to the completeness of interpretations regarding "atomizers," there is much useful information in these chapters.

Chapter 4 in particular deals with fuel pumps. The points for and against various designs are well brought out, with good reasoning and useful suggestions. Chapter 5 presents the importance of rigid oil engine frame work and indicates how the latter differs in steam engine practice. Chapter 6 gives various illustrations of framing designs such as are commonly adapted for marine uses.

Chapters 7 and 8 deal with cylinder and water jacket designs, while chapter 9 reviews the arrangement and types of cylinder heads from the viewpoint of relation between design and operation. This topic may be considered as general, but much still remains to be said in regard to preventing cracking of cylinder heads in larger engines.

Piston rings are discussed in Chapter 10. The three succeeding chapters deal with the design of pistons, the influence of the structure having bearing on the type of design, and the importance of timing lubrication of same. Those familiar with this subject will readily understand that the last word has not yet been said in this connection.

Major bearings, considered from the viewpoint of maintenance and adjustment; valve gear fundamentals, illustrated by diagrams and views; typical starting valve and control methods; and reversing systems as found in practice, are discussed in the remaining chapters.

In conclusion, the author's intention was not to give an exhaustive treatise on every subject in the book, but to bring before the reader the principles underlying various designs of oil engines, embodied in a manner interesting not only to engineers and designers, but also to operators, for whom it contains much useful information.—*Huldreich Egli*.

Das Wasser in Der Dampf- und Wärme-Technik. C. BLACHER. Leipzig: Otto Spamer. 294 pp. Bd. G. M. 18.0; paper G. M. 16.50. Reviewed in

Chem. and Ind., **45**: 11, 188, 1926. From Chem. Abst., **20**: 1877, June 10, 1926.—*R. E. Thompson.*

Chemische Technologie des Wassers. W. Olszewski. Berlin: Gruyter & Co. 138 pp. R. M. 1.25. From Chem. Abst., **20**: 1877, June 10, 1926.—*R. E. Thompson.*

Étude sur les eaux sulfureuses de Pietropola-les-Bains (Corse). J. Richaud. Montpellier: Impr. Firmin & Montane. 55 pp. From Chem. Abst., **20**: 2037, June 20, 1926.—*R. E. Thompson.*